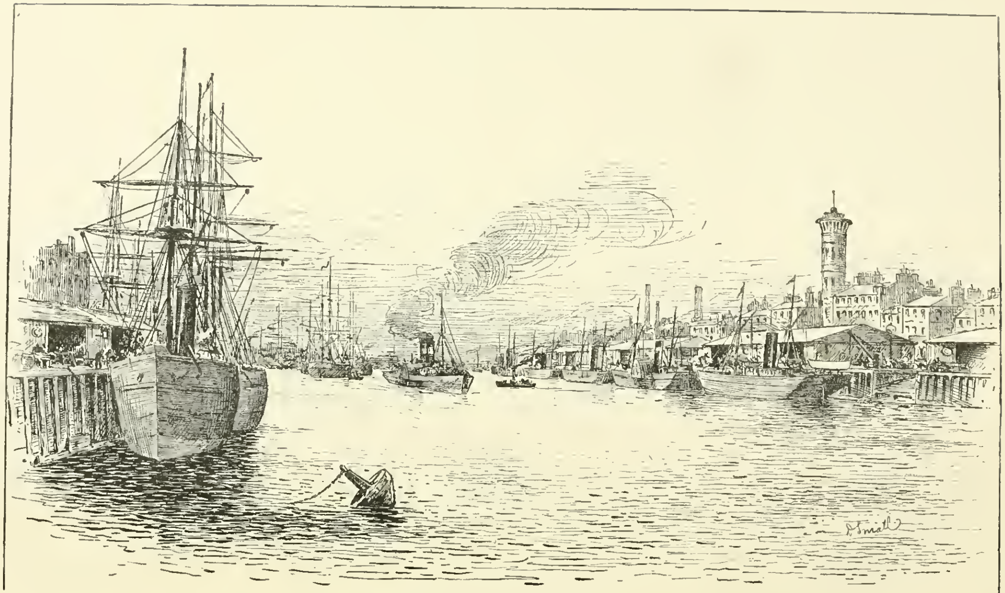
THE CLYDE

FROM ITS SOURCE TO THE SEA.

W. J. MILLAR, C.E.

THE CLYDE.



THE HARBOUR, GLASGOW.

THE CLYDE,

FROM ITS SOURCE TO THE SEA,

ITS DEVELOPMENT AS A NAVIGABLE RIVER,
THE RISE AND PROGRESS OF MARINE ENGINEERING AND SHIPBUILDING
ON ITS BANKS, AND THE LEADING
HISTORICAL, GEOLOGICAL, AND METEOROLOGICAL FEATURES OF
THE CLYDE VALLEY.

BY

W. J. MILLAR, C.E.,

Secretary of the Institution of Engineers and Shipbuilders in Scotland;
author of "Principles of Mechanics;"
"Studies in Physical Science;" "An Introduction to the Differential and Integral Calculus;" &c.

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PREFACE.

In the present volume I have endeavoured to give an outline of the principal features of the River Clyde, and of the commercial and industrial operations which have rendered it so well known as a navigable river.

Various books have appeared from time to time treating specifically of the leading characteristics of the district, and of the rise and progress of its industries.

The object of this work is rather to convey, in a condensed form, a general idea of the River, and of its varied surroundings—both of a topographical and a commercial character—together with some of the geological and meteorological features of the Clyde Valley.

For much of what is contained in the volume I am indebted to already published works, and to various individuals and business firms, who readily responded to inquiries on special points of a commercial, mechanical, or scientific nature; also to many personal friends, who have kindly communicated valuable information, especially about old Glasgow, the river, and early steamboats.

Throughout the text I have endeavoured to acknowledge the sources of all the quotations or special information obtained, and of the drawings and photographs lent for the purpose of illustration. The picturesque scenes have been drawn by D. Small and John Blair.

W. J. MILLAR.

GLASGOW, *May*, *1888*.

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THE CLYDE:

FROM ITS SOURCE TO THE SEA.

Chapter I.—DESCRIPTIVE.

The traveller by the Caledonian Railway after passing Carstairs finds himself rising rapidly as he enters the mountainous district to the south. On the right the fine conical form of Tinto stands like a guardian of the pass. As he speeds onwards the valley narrows, with great swelling hills on either side. The river Clyde, which the line crossed shortly after leaving Carstairs, is once more alongside, and as the iron horse speeds his way upwards the long train dashes across the winding stream, which is now seen hurrying onwards with more rapidity than when it was first met lower down, where it lazily moved among the meadow-lands.

A well-made road is also observable, being the old mail-coach route to Carlisle. This road was laid out by Telford, a celebrated engineer of nearly a century ago, who, from being a shepherd boy on the slopes of the Eskdale Hills, rose to design some of the most important engineering works carried out at the commencement of the present century. As a road-maker Telford was a worthy successor to the old Roman engineers who have left so many records of their skill and enterprise throughout our country. The present road from Carlisle to

Glasgow is pretty much in the line of the early Roman road which passed north from the termination of Hadrian's Wall at the Solway to the Wall of Antoninus between the Clyde and the Forth. Branches from this road ran down the Clyde Valley to the termination of the latter wall, and passing over the site of Glasgow, reached the Roman station situated near the town of Paisley, which is supposed by some to be the Vanduara of the Romans.

The road, rail, and river are all at this point close alongside one another in the narrow valley. It is not until an elevation of about 1000 ft. is reached that the river parts company, and winding along an upland valley to the right, stretches away like a silver thread into the dark and misty recesses of the Lowther Hills. Curiously enough, this longer terminal feeder of the stream we have been following does not carry the name we know it by farther down, but a shorter branch coming from the hills to the left, called Clydes Burn, is sometimes spoken of as the source of the Clyde. The longer branches, called the Powtrail and Daer Waters, flow from the amphitheatre of hills bounded by Queensberry Hill to the south; of these branches the Daer Water is the more important feeder. According to the Ordnance Survey the river Clyde is first known by that name after the junction of the Powtrail and Daer Waters.

The course of the Clyde is at first in a northerly direction, after which it trends to the east, and passing near Biggar, wheels round in a roughly-semicircular curve. It then starts off in a north-westerly course, which it more or less keeps until, reaching the Firth of Clyde at

Greenock, its waters flow seawards in a southerly direction. The length of the river from its source to below Greenock, where the Firth of Clyde begins, may be taken at 100 miles, and the total fall or difference of level between the same points is about 2000 ft. The area of the basin or prolonged valley through which its course flows is about 1600 square miles. Throughout this course great variations of fall occur, notably at the Falls of Clyde, where the total difference of level from above Bonnington to the foot of Stonebyres Falls is 350 feet.

The sources of the Clyde, lying as they do about the centre of the southern part of Scotland and amongst the high hills south of Tinto and around the Moffat district (some of which rise to 2600 and 2700 feet above the level of the sea), are naturally associated with other waters which also in their turn play an important part in the topography of the district, and many of which are immortalized in Border song and story. Thus within a short distance of the so-called springs of the Clyde, and on the other side of the hills to the eastward, rises the classic Tweed, and not far to the east and south the important tributaries of the latter, the Yarrow, Ettrick, and Teviot; whilst just over the summit level the Annan darts away to the south, making for the far-distant and blue outline of Skiddaw beyond the wide and rapid Solway.

Tributaries of the Nith flow towards the south-west from the western sides of the hills bounding the valley, and on the western side Douglas Water flows northwards, joining the Clyde itself west of Tinto.

Wilson, in his poem of "The Clyde," thus describes the surroundings:

> "From one vast mountain bursting on the day,
> Tweed, Clyde, and Annan urge their separate way.
> To Anglia's shores bright Tweed and Annan run,
> That seeks the rising, this the setting sun."

The district around the upper waters of the Clyde is wild and bleak, and across the hills on the western side lies the Enterkin Pass, thus described by Defoe:

"From Drumlanrig I took a Turn to see the famous Pass of *Enterkin* or *Introkin* Hill: It is indeed not easy to describe; but by telling you that it ascends through a winding Bottom for nearly half a Mile, and a Stranger sees nothing terrible, but vast high Mountains on either Hand, tho' all green, and with Sheep feeding on them to the very Top; when, on a suddain, turning short to the left, and crossing a Rill of Water in the Bottom, you mount the Side of one of those Hills, while, as you go on, the Bottom in which that Water runs down from between the Hills, Keeping its Level on your Right, begins to look very deep, till at Length it is a Precipice horrible and terrifying; on the left the Hill rises almost perpendicular, like a Wall; till being come about half Way, you have a steep, unpassable Height on the Left, and a monstrous Casm or Ditch on your Right; deep almost, as the Monument is high, and the Path, or Way, just broad enough for you to lead your Horse on it, and, if his Foot slips, you have nothing to do but let go the Bridle, least he pulls you with him, and then you will have the Satisfaction of seeing him dash'd to Pieces, and lye at the Bottom with his four Shoes uppermost."

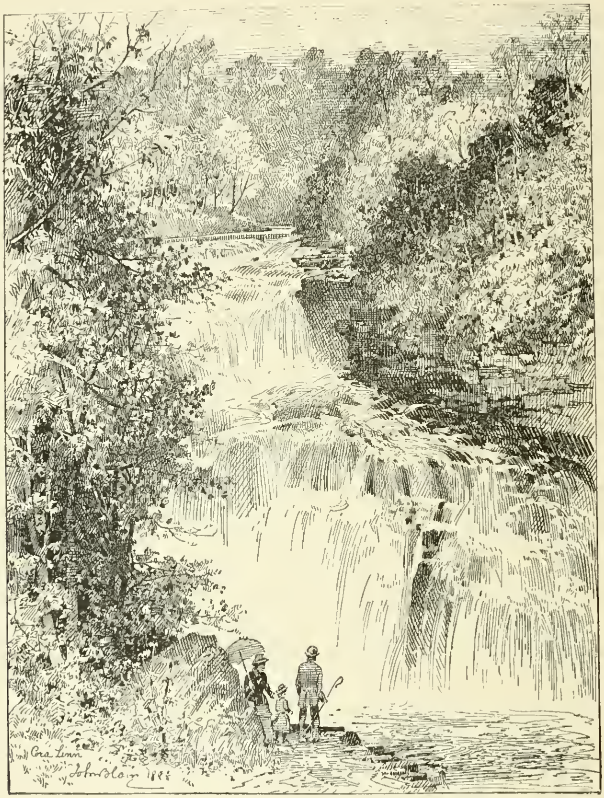
And at a much later date the genial author of *Rab and his Friends,* the late Dr. John Brown, writes of the same glen: "There is something marvellous in the silence of these upland solitudes; the burns slip away without noise; there are no trees, few birds; and it so happened that day that the sheep were nibbling elsewhere, and the shepherds all unseen. There was only 'the weird sound of its own stillness' as we walked up the glen. It was refreshing and reassuring after the din of the town, this out-of-the-world, unchangeable place."

And one of the doctor's friends, inspired by the spirit of the scene, wrote:

> "Yet, I know, there lie, all lonely,
> Still to feed thought's loftiest mood,
> Countless glens undesecrated,
> Many an awful solitude.
>
> "Many a burn, in unknown corries,
> Down dark linns the white foam flings,
> Fringed with ruddy-berried rowans,
> Fed from everlasting springs.
>
> "Still there sleep unnumbered lochans,
> Craig-begirt 'mid deserts dumb,
> Where no human road yet travels,
> Never tourist's foot hath come."

The superficial features of the valley of the Clyde are very varied. Rising amongst the great hills of the Southern Highlands, the course of the river lies for a time amid the moors and rough pasture of these uplands. Lower down, and above the Falls, it moves slowly onwards through spreading meadows, with a wide prospect around of cultivated and wooded slopes. At

Bonnington Fall, however, the scene changes to one of combined beauty and grandeur not easily surpassed. The



Cora Linn—Falls of Clyde.

river, after taking its headlong plunge, rushes along for a couple of miles through a deep and narrow chasm,

whose jagged rocks seem to torment and vex the once placid stream, until, after its triple leap at Cora Linn, it escapes for a time into the opener valley below. But along with all this impressive grandeur we have the softening effect of the foliage from the thousand trees and shrubs which clothe the rocky crags, and the varied bloom of the wild flowers amongst the grassy slopes.

Here the calm beauty of the scene appears to have affected Wordsworth, who writes:

> "In Cora's glen the calm how deep,
> That trees on loftiest hill
> Like statues stand, or things asleep,
> All motionless and still."

And now for a few miles we see the river once more comparatively quiet, and notice the angler wading in the shallows, or poised on some rocky ledge, deftly throwing his deceptive fly to catch the sportive trout. The deep and sombre ravine of Cartland Crags is passed on the right, with its caves where Wallace found a hiding-place, and its magnificent viaduct by Telford, with its tapering piers and arches rising high overhead.

Once more at Stonebyres the river makes a series of leaps through a rocky chasm, and thereafter flows onward more leisurely through the orchard district above Hamilton. Here let us take leave of the Falls, saying with Sir John Bowring:

> "O! I have seen the Falls of Clyde,
> And never can forget them;
> For Memory, in her hours of pride,
> 'Midst gems of thought will set them,
> With every living thing allied:
> I will not now regret them."

This part of Lanarkshire appears to have been celebrated for its orchards from an early date. Thus we find in the Statistical Survey of Scotland:—"Orchards are of considerable antiquity on the Clyde. Merlin the poet, who wrote about the middle of the fifth century, celebrates Clydesdale for its fruit. The soil and climate being inland, and consequently free from the blasting influence of mildews and fogs, may account for its being so favourable for the cultivation of orchards. At first they were planted in the shape of gardens, attached to houses for the accommodation of resident families. For two centuries or more they have been cultivated as a source of profit; they chiefly prevail, and are most extensive and productive, on the north bank of the Clyde, having a southern exposure, though on the south bank there are also a considerable number, and some of them very fruitful."

Campbell thus records his memories of a visit to this district:

"It was as sweet an autumn day
As ever shone on Clyde,
And Lanark's orchards all the way
Put forth their golden pride;
Even hedges busked in bravery,
Look'd rich that sunny morn;
The scarlet hip and blackberry
So prank'd September's thorn."

The area of ground set apart for orchards in Scotland appears to be nearly 2000 acres, of which Lanarkshire possesses nearly one-third. The fruits cultivated in the Clyde orchards are apples, pears, plums, strawberries, and gooseberries. Apples are not cultivated now to the same

extent as formerly, owing to the importation of American varieties. The culture of strawberries has very much increased of late years, arising in part from the extensive manufacture of this and other fruits into jams and jellies, owing to the cheap price of sugar.

Clydesdale has long been famed for its horses, many of which are now exported to America, and fetch large prices on account of their great strength and other valuable qualities. The fine lorry horses in Glasgow, drawing their heavy loads, carefully looked after and well harnessed, are a well-known sight, especially on the carter's holiday, or mayhap during some civic procession, when they turn out in all the glory of their natural strength.

A writer in the *Transactions of the Highland and Agricultural Society of Scotland* thus describes them; he says: "Clydesdale horses, the best type of which are perfect models of strength, with shapes eminently calculated for endurance and activity, undoubtedly are, as generally admitted, the best breed for farm work." On the upland farms the powerful draught of the Clydesdale soon adds furrow to furrow in the stiff soil, and at evening we see the cheery ploughman and "the miry beasts returning from the plough."

The angler can find plenty of sport on the Clyde. Among the lonely hills, on the rocks or shallows at the foot of the Falls, further down in the Bothwell haughs, or again at Carmyle in the shade of the Kenmuir woods, he will find the trout rising to his fly. Regarding this Mr. Robert Blakey in his book on *Angling* says: "The waters from Elvanfoot to the primary rivulets of the river are full of fine trout; and there is a splendid fly-

fishing range of many miles in extent. The streams are numerous and rippling. The trout found in these waters are of very good quality. The *Falls* effectually prevent salmon ascending higher up than a few miles below Lanark. The rod-fishing is interrupted by the *Falls*, which are objects well worthy of a visit from the tourist. Below them good fishing again commences, and continues down to within three miles of Glasgow Bridge. There are no tributaries of the Clyde of so much fishing repute as to induce the tourist to turn aside from the main stream. If he fishes it properly from its source to the confines of Glasgow he will find the range of waters very interesting, and capable of affording him ample sport."

Following the course of the river we reach Hamilton, with its ducal palace showing above the tall trees which cover the haugh lands on the left bank, whilst indications of the utilitarian progress of the age may be seen on the opposite side in a briskly-going colliery placed close to the line of the old Roman road. A fine sweep of the river with high terraced banks on the right, on which part of the town of Bothwell is built, also suggests a time long before our historical reckoning when a wider stream swept past, or estuarine waves beat, on the higher slopes, which at that time probably formed an island.

Bothwell Bridge, as originally built, appears to have been of the style commonly adopted by the earlier bridge-builders, that is, a high arch or arches in the centre, nearly if not altogether semicircular, with smaller arches towards the ends or sides of the river. The roadway was also narrow, and this, combined with the great steepness of the

gradients on each side of the central arches, must have rendered the passage of wheeled vehicles a laborious process. We have still a number of such old bridges remaining in different parts of the country; some preserving the early characteristics referred to, others showing improvements in wider roadways and less steep gradients.

The Bridge appears to have been built at an early date. It was originally only 20 feet wide, had a steep roadway, and was fortified by a gateway at the Hamilton side. It appears to have retained its smaller side arches till 1826, when it was widened; the addition which was made on the up side was 22 feet. This difference in the mason work is readily noticeable, as the old or down-stream part of the centre arches is of a kind of ribbed work, the new part being plain in the soffit or under part of the arch. The piers, which are 15 feet thick, have heavy starlings both on the up and down side of the stream. Some years ago the width was still further increased by iron work carrying a footway 5 feet wide. The footway thus projects from the stonework of each side, and the carriage roadway, which is 30 feet wide, extends over the whole breadth of the stone structure. There are now four arches of 45 feet span, and the length of the bridge from bank to bank is 225 feet.

The roadway of the bridge is now level, and the road on each side rises with a considerable gradient. The old road on the Glasgow side was much steeper than the new approach, and had in addition the disadvantage of leaving the bridge at nearly a right angle, turning sharply in the reverse direction as it ascended the hill. In coming

down this hill on a dark night, taking the sharp turns required to get on the bridge, must have called for all the well-known skill of the drivers of the mail-coaches of the old days. Standing on the bridge and viewing the changes which have taken place there, it is difficult to picture to one's self the unsettled and troublous times of our forefathers, when the struggle for its possession took place. When

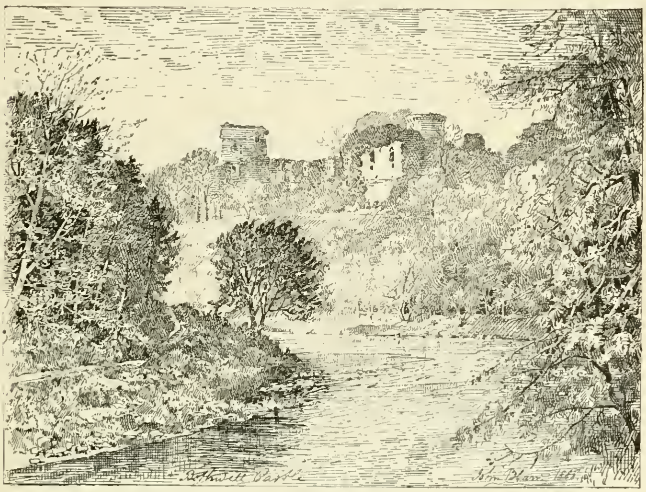
> "The muskets were flashing, the blue swords were gleaming,
> The helmets were cleft, and the red blood was streaming."

Passing the Blantyre mills, where at one time the great African traveller Livingstone worked when a boy, and who was born at the village of the same name adjoining, the river flows through the steep and beautifully-wooded slopes between Blantyre Priory and Bothwell Castle.

After passing Uddingston the course of the river is through Kenmuir Wood and past Carmyle—favourite haunt of fisherman and artist—and as it winds along in the flat grounds it passes in turn some well-known landmarks, such as the Clyde Iron Works, the site of the old Glasgow Water Works, and then through the high arches of the old bridge leading to Rutherglen, the handsome tower of the town building of this ancient burgh rising high on the left. Hugh M'Donald in his interesting *Rambles Round Glasgow*, says: "The steeple of a small though very ancient church, on the site of which the present one was built, stands in the vicinity, a venerable memorial of bygone ages, associated with recollections of several interesting events in Scottish history. According

to Blind Harry, the biographer of Wallace, a peace was concluded here between England and Scotland in 1297."

Sweeping in a fine curve round Glasgow Green, and passing through the arches of the various bridges which connect the northern and southern parts of the city, the



Scene on the Clyde at Bothwell Castle.

river holds its way to the sea, hemmed in now by quay walls and dykes, with the buckets of the dredger constantly scooping out the loose material from the bottom, and thus fitting it to bear on its now broadening bosom the vast fleet of vessels, new and old, which constantly ply on its waters.

The valley of the Clyde from Glasgow downwards is wide and open, with great areas of comparatively flat

and fertile land stretching back on either side to the ranges of hills which bound its course to north and south. Several fine old mansion houses are still to be seen on the banks, many of them now incorporated in the numerous shipbuilding yards which line the river.

Campbell—with more of sympathy for nature than for the triumphs of science and art—expresses himself forcibly on the changes which have taken place through the shipbuilding and engineering industries on the river banks:

> "And call they this Improvement?—to have changed
> My native Clyde, thy once romantic shore,
> Where Nature's face is banished and estranged,
> And Heaven reflected in thy wave no more;
> Whose banks, that sweeten'd May-day breath before,
> Lie sere and leafless now in summer's beam,
> With sooty exhalations covered o'er;
> And for the daisied greensward down thy stream
> Unsightly brick-lanes smoke and clanking engines gleam."

About 10 miles from Glasgow the hills on the north side of the valley approach the river, and from a slight elevation called Dalnottar Hill a magnificent view is obtained of the now widening Clyde, with Dumbarton Rock and the distant hills above Dunoon filling up the distance. This view has brought several artists of high reputation to portray its features on canvas. Lovely at all times as the view is, it is specially so on a fine summer evening, when the sun, now nearing the western hills above the Holy Loch, throws a long trail of luminous splendour all along the line of the flowing stream.

Near this point the Forth and Clyde Canal joins the

river, the Roman wall terminates but a short distance below, whilst the adjacent village of Old Kilpatrick has the special prestige of being, according to authentic tradition, the birthplace of St. Patrick, Ireland's patron saint. The harbour of Bowling, where the bulk of the river steamers quietly doze away during the winter months after their busy summer's work, the monument to Henry Bell, who has the distinguished honour of having started the first passenger steamer in European waters, the *Comet*, and the great basaltic hill of Dumbuck completely fill the eye of the observer as he contemplates the scene; whilst, turning to the southern side, he sees the handsome mansion and grounds of Erskine House.

Onwards the river sweeps to the sea, hurrying past the Vale of Leven, which opens out to the north, with the massive form of Ben Lomond overlooking the surrounding hills. Wide stretches of sandy flats now show themselves when the tide is out, but the navigable part is kept clear by training walls and constant dredger work, and the sea breezes now curl the waters as they flow past Port-Glasgow and Greenock, to mingle with the salt waters of the tidal wave which beats upon the coast.

Around us now is a varied scene: shipping, from the full-rigged ship and the 5000-ton steamer to the 5-ton yacht and steam-launch; towns and villages lining the shores with the villas and mansions of the prosperous Glasgow merchant; while we may catch a glimpse of the evening steamers racing from the nearest railway terminus, each with its load of business men returning to their families at the coast. The beauties of the Firth of Clyde are deservedly well known, and for this we have

to thank the enterprising steamboat-owning firms, who have for more than half a century been actively engaged in opening up the various now well-known routes and consolidating their efforts in connection with railway and coaching transit.

The Firth of Clyde just below the "Tail of the Bank" presents many of the well-known characteristics of the West Highland scenery, which in turn is like a miniature Norwegian coast-line. The arms of Loch Long, the Gareloch, and Holy Loch run into the wild Highland hills beyond, like the fiords of the old Norse land, whilst the Alpine peaks of Arran are seen far away over the low and fertile hills of Bute.

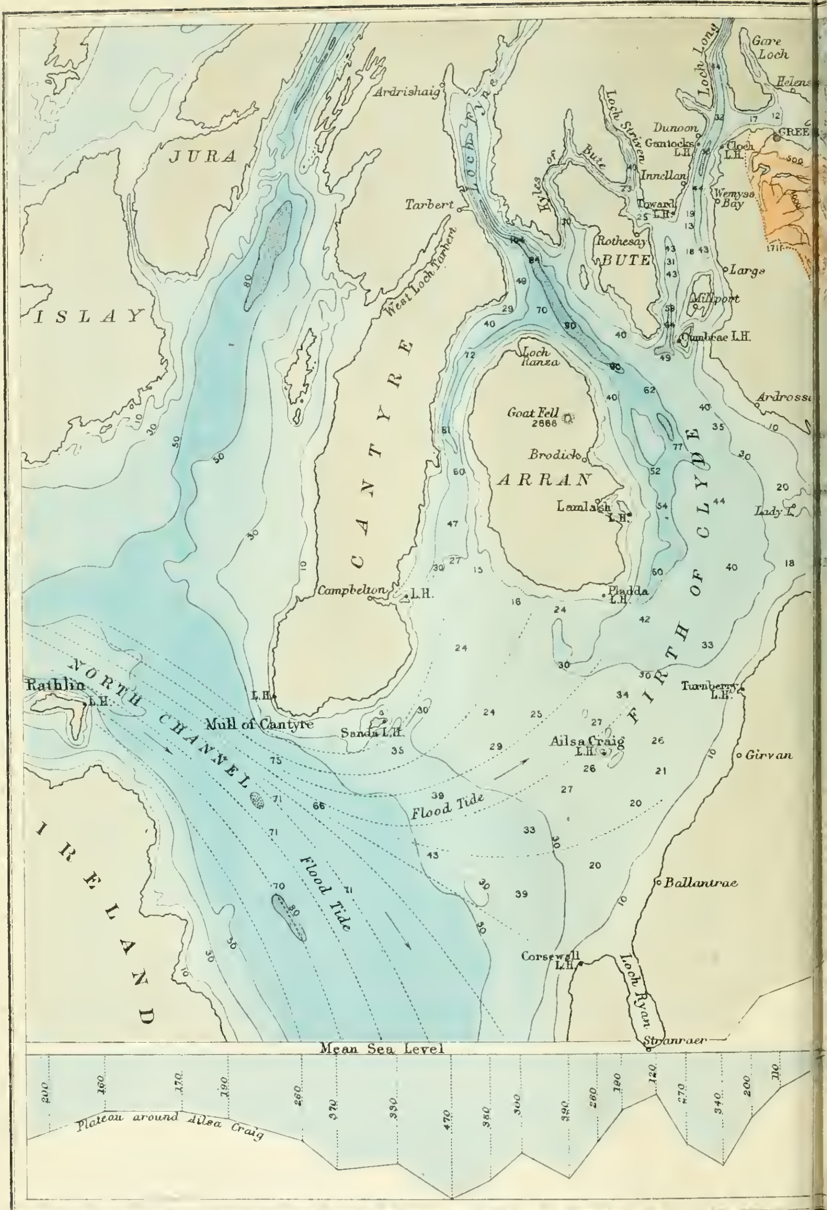
> "In night the fairy prospects sink
> Where Cumray's isles, with verdant link,
> Close the fair entrance of the Clyde;
> The woods of Bute no more descried,
> Are gone."

Chapter II.

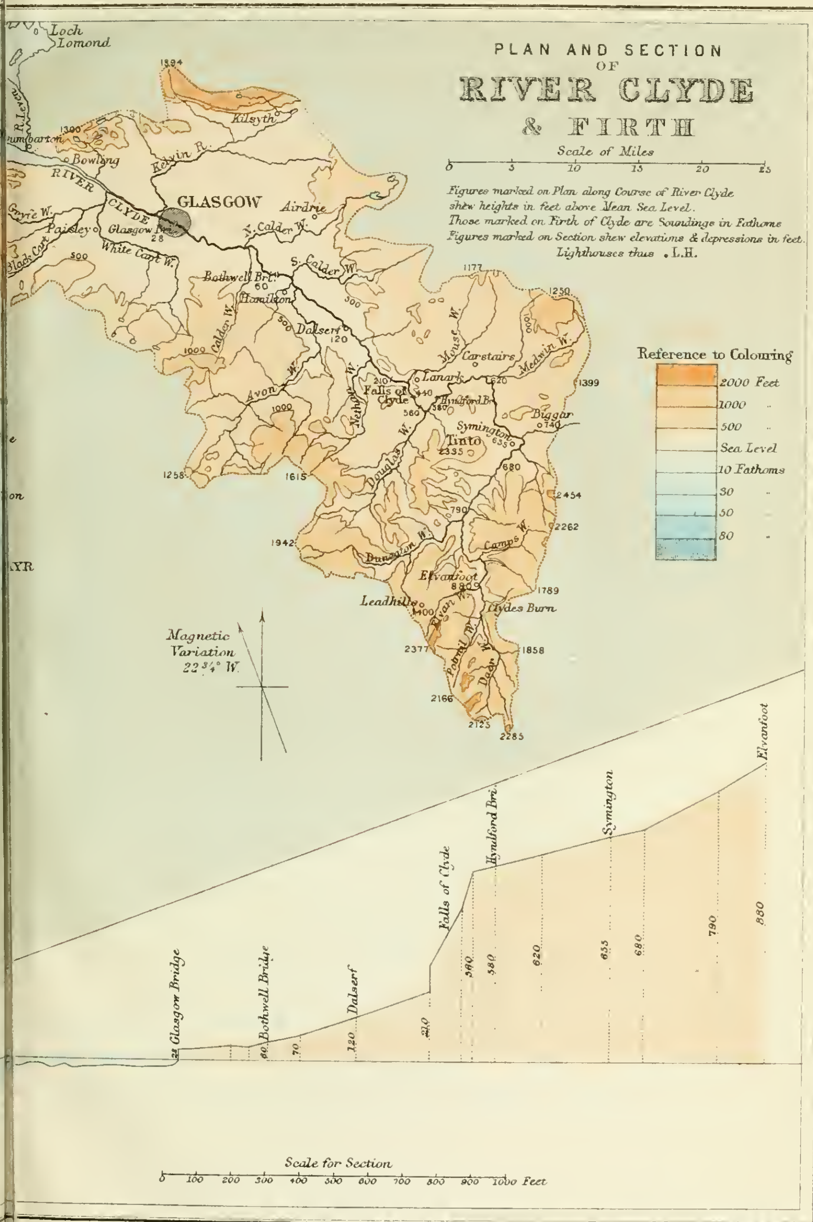
TOPOGRAPHICAL AND TRIBUTARIES, &c.

From its source downwards to Glasgow the Clyde flows through Lanarkshire; afterwards, until about Greenock, its course is between Dumbartonshire on the north and Renfrewshire on the south. The fertile slopes of Ayrshire and the Highland hills of Argyleshire continue the boundary to the now widening waters of the Firth.

Lanarkshire, or Clydesdale, is bounded on the north



JURA
ISLAY
CANTYRE
ARRAN
BUTE
IRELAND
NORTH CHANNEL
FIRTH OF CLYDE
Ardrishaig
Tarbert
West Loch Tarbert
Loch Fyne
Kyles of Bute
Loch Striven
Loch Long
Gare Loch
Dunoon
Gantocks L.H.
Innellan
Toward L.H.
Rothesay
Wemyss Bay
Cloch L.H.
Largs
Millport
Cumbrae L.H.
Loch Ranza
Goat Fell 2866
Brodick
Lamlash L.H.
Ardrossan
Lady I.
Campbelton
L.H.
Pladda L.H.
Rathlin L.H.
Mull of Cantyre
Sanda L.H.
Ailsa Craig L.H.
Turnberry L.H.
Girvan
Flood Tide
Ballantrae
Corsewall L.H.
Loch Ryan
Stranraer
Mean Sea Level
Plateau around Ailsa Craig



J. Bartholomew, Edin.

and north-west by the counties of Stirling, Dumbarton, and Renfrew; on the north-east by Edinburgh and Linlithgow; on the east by Peebles; on the south by Dumfries; and on the south-west and west by Ayrshire. It is situated between 55° 54′ and 55° 25′ of north latitude, and 3° 25′ and 4° 18′ of west longitude. The length from north-west to south-east is about 50 miles; and the greatest breadth from north-east to south-west is 34 miles. It contains an area of 568,867 acres, or 888 square miles.

Lanarkshire is subdivided into three districts, called the Upper, Middle, and Lower Wards. In the Upper Ward, of which Lanark is the chief town, are the parishes of Carluke, Lanark, Carstairs, Carnwath, Dunsyre, Dolphinton, Walston, Biggar, Liberton, Lamington and Wandell, Coulter, Crawford, Crawfordjohn, Douglas, Wiston and Roberton, Symington, Covington, Pettinain, Carmichael, and Lesmahagow. The Middle Ward, of which the town of Hamilton is the centre, comprehends the parishes of Hamilton, Blantyre, East Kilbride, Avondale, Glassford, Stonehouse, Dalserf, Cambusnethan, Shotts, Dalziel, Bothwell, New Monkland, and Old Monkland. The Lower Ward contains the parishes of Cadder, Cambuslang, Rutherglen, Carmunnock, and part of Govan and Cathcart. In and around Glasgow are the parishes of the City, Barony, Calton, Gorbals, Maryhill, Springburn, and Shettleston.

Dumbartonshire, in old times known as The Lennox, is more or less mountainous, with some arable land near the Clyde. Loch Lomond stretches for miles towards the Highland mountains, and the "Lofty Ben Lomond," over 3000 feet in height, rises from the eastern side of

the loch, seen from afar, whether from Highland hill or Lowland vale. The area of this county is 172,677 acres, of which the waters of Loch Lomond itself form nearly one-eighth part. The town of Dumbarton, famous for its ship-building enterprise, is the principal industrial centre.

Renfrewshire extends to 162,427 acres, and is much diversified as to soil, minerals, towns, &c., and, like Lanarkshire, contains many important industrial centres of population. From the returns for 1887–88 the valuation of Lanarkshire appears to be £2,079,860.

Several important tributary streams enter the Clyde along its course, and are associated with many circumstances and places of interest. Wilson, in his Clyde poem, enumerates these streams, giving each its particular characteristic, thus:

> "Glengonar's dangerous stream was stained with lead;
> Fillets of wool bound dark Duneaton's head;
> With corn-ears crowned, the sister Medwins[1] rose,
> And Mouse, whose mining stream in coverts flows;
> Black Douglas, drunk by heroes far renowned,
> And turbid Nethan's front with alders bound;
> Calder, with oak around his temples twined,
> And Kelvin, Glasgow's boundary flood designed;

[1] A small branch of the South Medwyn runs off towards the east, near Garvaldfoot, changes its name soon to the Tarth, passes out the Lyne, and through it to the Tweed. The fact or phenomenon that salmon have been caught in the Clyde above the majestic and lofty cataracts of that noble river is accounted for on the supposition that, at the spawning season, some of the fish diverge from the Tweed up the Lyne and the Tarth till they turn the fork of the South Medwyn, and then go down the Clydesdale section of that curious stream. The point at which the Medwyn splits is, in consequence, popularly called the Salmon Leap.—Note to Wilson's "Clyde," by Dr. Leyden.

Cart's sombre stream, which deep and silent moves,
Where kings and queens of old indulged their loves;
Leven, which growth and infancy disdains,
Rushing in strength mature upon the plains."

John Wilson was born near Lanark in the year 1720. He wrote several pieces of a descriptive and dramatic character. His poem of "The Clyde" was published in 1764. Wilson afterwards was appointed to the Grammar-school of Greenock in 1767, under the condition that he would give up "the profane and unprofitable art of poem making." This was a sore blow to the poet, but he accepted the position, and devoted himself closely to his work, which he carried on till within a year or two of his death in 1789.

Allan Ramsay was a native of Leadhills, where he was born just about two hundred years ago. As described by himself:

"Of Crauford-muir, born in Lead-hill,
Where mineral springs Glengonir fill,
Which joins sweet flowing Clyde,
Between auld Craufurd-Lindsay's towers,
And where Deneetnie rapid pours
His stream through Glotta's tide."[1]

He afterwards went to Edinburgh, where, amongst many pieces, his "Gentle Shepherd" was published in 1725. He died in Edinburgh in 1757, aged 73.

Taylor and Symington, who were associated with the first attempts at steam navigation made by Patrick Miller

[1] The word Glota, the old Roman name for the river Clyde, is still kept up in the word "Glotiana," one of the "nations" in which the students of Glasgow University vote for the Lord Rector.

of Dalswinton just a century ago, were also natives of this district.

Lanark is an ancient town and royal burgh, situated a few miles north of the Clyde. According to some it was a seat of royalty and the home of an early parliament in the tenth century. Its associations with the patriot Wallace in his early struggles are graphically portrayed in the *Scottish Chiefs*, and it was doubtless one of the many points in the Roman system of military ways which passed down the Clyde valley at the eastern end of the town.

A local guide-book states that "Lanark formerly enjoyed the privilege of keeping the standard weights of the kingdom. These weights were stamped with a spread eagle with two heads, the arms of the burgh. In 1790 they were measured by Professor Robison of Edinburgh, and a second time (about 1800) for the purpose of rectifying those of Edinburgh."

Here the ruins of the church of St. Kentigern, dating from the early part of the twelfth century, are interesting as an example of the "Early English" architecture. The Lee Aisle is attached to the building, and a number of quaint old tombstones may be seen in the cemetery, together with a handsome monument erected to the martyrs who suffered for conscience sake and belonged to the district.

Sir Walter Scott, in his tale of the *Talisman*, tells us that this talisman was an amulet supposed to possess special healing virtues, and which was brought from the East in the fourteenth century by Sir Simon Lockhart of Lee and Cartland, who "left it to his heirs, by whom, and

by Clydesdale in general, it was, and is still, distinguished by the name of the Lee-penny, from the name of his native seat of Lee."

The history of bells is always curious and interesting. One of those in the spire of the parish church has been recast several times, the earliest date on it being 1110.

One of the principal tributary streams of the Clyde is the Douglas Water, an important stream, draining the large district to the south of Lanark and the Falls of Clyde, and lying to the west of Tinto. The beautiful and fertile valley through which this stream flows is called Douglasdale, the parish of Douglas extending from the Clyde for about 12 miles. The parish is said to take its name from the stream, *Douglas* signifying a dark colour, and which appears to have given the surname of Douglas to the family who so powerfully affected the history of Scotland in earlier days. Douglas Castle, the "Castle Dangerous" of Sir Walter Scott, played, like other strongholds, an important part in the War of Independence, and he states that its surrender by the English about the year 1306 "was the beginning of a career of conquest which was uninterrupted until the crowning mercy was gained in the celebrated field of Bannockburn."

The Mouse enters the Clyde on the right bank a short distance below Lanark. It is principally noticeable from the bold and striking scenery near its point of junction with the river, where it flows through the chasm of the Cartland Crags, spanned by Telford's viaduct carrying the Glasgow road. Writing of Telford's works in roads and bridges, Smiles says: "Owing to the mountainous

nature of the country through which Telford's Carlisle and Glasgow road passes, the bridges are unusually numerous and of large dimensions. Thus the Fiddler's Burn Bridge is of three arches, one of 150, and two of 105 feet span each. There are fourteen other bridges, presenting from one to three arches, of from 20 to 90 feet span.


Thomas Telford.

But the most picturesque and remarkable bridge, constructed by Telford in that district, was upon another line of road subsequently carried out by him, in the upper part of the county of Lanark, and crossing the main line of the Carlisle and Glasgow road almost at right angles. It was carried over deep ravines by several lofty bridges, the most formidable of which was that across the Mouse Water at Cartland Crags, about a mile to the west of Lanark. The stream here flows through a deep rocky chasm, the sides of which are in some places about 400 feet high. At a point where the height of the rocks is considerably less, but still most formidable, Telford spanned the ravine 129 feet above the water."

The Nethan enters the Clyde on the left below Stonebyres Fall. It flows through the parish of Lesmahagow

(famous for its gas-coal), and not far from its junction passes through a rocky gorge, on the top of which stands the ruins of Craignethan Castle, believed to be the prototype of the Castle of Tillietudlem in *Old Mortality*. A considerable extent of Silurian rocks are met with in this district, some of the characteristic Lingula fossils being found in the rocks of the Nethan.

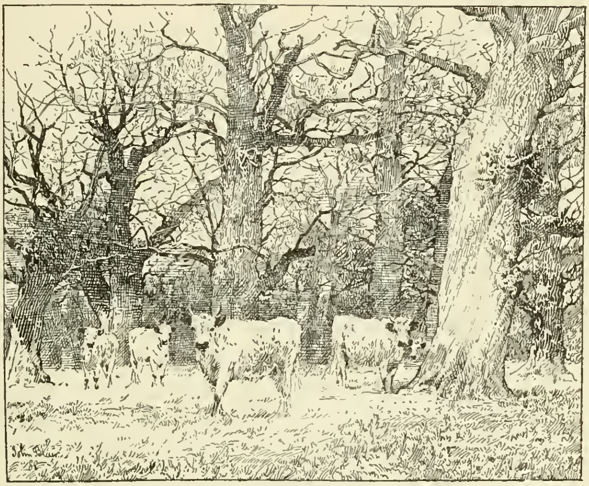
Ordnance survey and Ordnance datum are well-known terms, especially the former, the latter belonging more specifically to the province of the engineer. We often speak of differences of levels of places and compare their heights; and if we look over the Ordnance maps, which indeed so well repay careful study, we see not only the country mapped out with accuracy, but we also find certain figures dotted over the surface, showing the elevation of the land above the fixed mean water datum at Liverpool.[1] The principles underlying such a survey as that which has been carried out in this country depend upon the science of spherical trigonometry, and are more or less complex in their applications to the necessary refinements entered into by the officers of the Survey. It may be interesting, therefore, to note that a native of the parish of Carluke (General Roy) appears to have been the first surveyor who carried out the earlier measurements of the base-lines required. Thus, in a recent notice the *Glasgow Herald*, referring to the work of General Roy and others about a century ago, says: "General Roy, apart altogether from later labours, may be said to have originated the Ordnance Survey as we

[1] This datum is a point 4·67 feet above the level of the old Dock Sill, Liverpool.

now understand the phrase. It is pleasant for west-country people to remember that this distinguished military engineer was a native of Carluke parish, Lanarkshire."

The Aven or Avon, doubtless from the British word for river, flows into the Clyde at Hamilton, and drains a good extent of country to the south. As it approaches the neighbourhood of Hamilton it finds its way through the fine old woods of Cadzow, whose old oaks, after braving the "battle and the breeze" of a thousand years, are, many of them, still flourishing, and likely to see many more changes in the coming years. Their battles have been mainly with the elements and the somewhat varying conditions of climate throughout the long centuries of their life; but they have struck root firmly, and borne themselves nobly and bravely against the winds and frosts of winter, and the no less trying droughts of summer. Some old veterans there are, hollowed out by time, into whose shelter we can gather; and as we stand within the oak walls, with their still vigorous foliage floating high above us, we seem to hear them whispering to one another old stories of the past, when the wild animals and their Caledonian hunters roamed beneath their branches, and the excitement of the chase or the din of war echoed through the far-stretching glades. Later on the merry hawking party with knights, ladies, and attendants, clad in the armour and gay attire of the middle ages glanced amidst the sombre depths of this forest, and in times nearer to our own, persecuted Covenanters sought shelter amid its friendly covering. And here, even yet, under these old

oaks, we have a remnant of the wild denizens of the primeval forest in the white cattle quietly feeding there. Cadzow, and Chillingham in England, seem to be the only places where the old breed of wild cattle now exists.



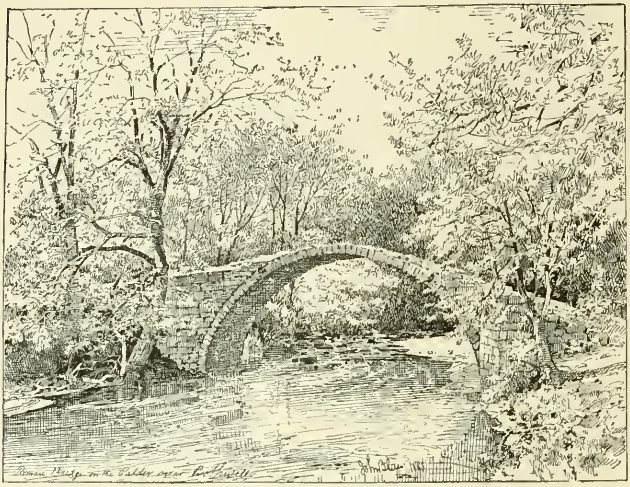
Cadzow Oaks and Cattle, Hamilton.

They are of a white colour with black muzzles, and appear still to retain traces of the wild and untamable spirit of their far-back ancestors of the Caledonian forest.

After passing the Avon we find three different streams bearing the name of Calder as tributaries, two of which flow in on the north side, and one on the southern side of the river. As the word *Calder* is said to indicate a place of wood and water, it is not strange that it should be applied to several of the well-wooded streams of this district. The South Calder Water is distinguished

for its fine semicircular arch, supposed to be of Roman origin, as it is on the line of the Roman road which ran along the north side of the Clyde.

A short distance below is the village of Bothwell with



Roman Bridge over the Calder.

its curious old church, thus described in the *Statistical Survey of Scotland*:—

"*The Old Church of Bothwell* is a very ancient structure, and presents a fine specimen of Gothic architecture. It was used in former times as the quire of the collegiate church of Bothwell. In Catholic times Bothwell was the most important of the five collegiate churches of Lanarkshire. It was established by Archibald Douglas, Lord of Galloway (who married Johanna Moray, heiress of Bothwell), 10th October, 1398, and was confirmed by

a charter from the king, 5th Feb. 1398–9. It was about this period that the present quire was built. The master-mason, as was indicated by an inscription in Saxon letters on a stone near the outer base of the old steeple, now removed, was Thomas Tron. The roof is arched and lofty, and presents the most remarkable feature of the building. On the outside it is covered with large flags of stone, hewn into the form of tiles resting on a mass of lime and stone, which in the centre is 11 feet in depth. The side walls are strengthened by strong buttresses to support the weight of the roof." The new parish church was built in 1833, and is in the Gothic style, to harmonize with the old church to which it is attached, a handsome tower, 120 feet high, rising at the junction of the two buildings. Joanna Baillie, celebrated as an authoress, was born in Bothwell Manse, her father, the Rev. James Baillie, D.D., being minister of the parish.

The Calder—sometimes called the Rotten Calder—rises in the trap-hills to the south of Kilbride, and flows more or less northwards through a district of much geological interest and picturesque beauty. Both coal and ironstone have been worked along the bed of this stream, the old entrance workings being still visible. Cement-stones and limestones, both commercially valuable, are worked at different parts of its course. One feature of special interest to geologists is that in passing along in its course from the hills to the Clyde it crosses the great "fault," which runs more or less parallel to the valley of the Clyde, and extends more or less from the Nethan, near its confluence with the Clyde, to about a mile or so to the south of Glasgow Bridge.

There is still another Calder flowing from the north and joining the Clyde almost opposite the Rotten Calder, below Uddingston.

The Kelvin is an important tributary of the Clyde, draining a considerable area from its source in the Kilsyth Hills till it falls into the river at Partick. Its course is interesting, as at several points it is not far from the line of the Roman Wall, and at Belmulie, a few miles north of Glasgow, it crosses a point where at one time a Roman station was placed.

The Cart enters the Clyde on the south side, a few miles farther down, passing to the west of the ancient burgh of Renfrew, and not far from Inchinnan, whose religious church history dates back to 1100—a grant to the Knights Templars being made at that time by David I. Two considerable streams—the White Cart and Black Cart—meet just a little above their junction with the Clyde, the Black Cart having been, shortly before the junction, supplemented by the waters of the Gryfe. These streams drain a large extent of country from their sources in the high hill ground bordering the southern valley of the Clyde, passing through well-cultivated and populous districts, abounding in fine scenery and varied associations, both of an antiquarian and commercial character.

The White Cart rises in the Mearns district, eleven miles south of Glasgow, and flows at first in a northerly direction, passing through the parish of Cathcart and near the ruined castle of the same name. Within a short distance is the field of Langside, the battle fought there in 1568 being so disastrous to the unfortunate Queen

Mary of Scotland. This stream then turns westwards, passing through the populous and industrial centre of Pollokshaws, and shortly afterwards near the now ruined Crookston Castle, a residence of the same ill-fated Queen in her earlier days. Flowing through the busy town of Paisley, the White Cart turns again northwards until it joins its brother with the dark cognomen, which latter rises in Castle Semple Loch, and flowing north-easterly is joined by the Gryfe Water, which rises on the western side of Renfrewshire behind Greenock, and flows through a long valley lying amongst the hills. The head-waters of the Gryfe are utilized for supplying the town of Greenock with water, and at Bridge of Weir a dam is thrown across to give water-power to the mills there.

Campbell sings of the Cart:—

"Oh, the scenes of my childhood and dear to my heart,
Ye green waving woods on the margin of Cart!
How blest in the morning of life I have strayed
By the stream of the vale and the grass-covered glade!"

Paisley appears to be situated on or near the site of the old Roman station of Vanduara, and has for long been a prosperous town, both in the early days of the hand-loom weaving industry, and later on when water-power and steam gradually superseded the use of hands, and the single work-room of the weaver was extended and enlarged to the factory with its looms and spinning-jennies for the manufacture of various fabrics. Now the great thread-mill, where miles of that indispensable material for sewing, whether by hand or by machine, is made, may be seen rising as a palatial-looking structure

many stories high. Our old friend Pennant, always keenly alive to facts and objects of interest, tells us that, "about fifty years ago the making of white stitching threads was first introduced into the west country by a private gentlewoman, Mrs. Millar of Bargarran, who, very much to her own honour, imported a twist-mill from Holland and carried on a small manufacture in her own family." This early and simple attempt was afterwards extended, and at the time of Pennant's visit the value of the thread manufacture had risen to nearly £50,000. Besides this the manufacture of lawns, silk gauze, and ribbons, was carried on, and the celebrated Paisley plaid, with its well-marked pine-cone pattern, became quite a fashion. Some of these latter industries have died out, but their place has been taken by others, and Paisley, with her 66,000 inhabitants, is as busy as ever manufacturing, besides thread and some other textile fabrics, starch, corn-flour, and machinery, while on the banks of the tributary Cart iron vessels of various kinds are now built.

Paisley has a long list of eminent men who have been born within her borders. Professor Wilson, the "North" of the *Noctes;* Wilson, the ornithologist; and the sweet singer, Tannahill, whose home is still shown where he worked at his loom; many others whose names are celebrated were natives of this busy industrial centre.

The Abbey Church is a fine old building, the style being early English Gothic. Adjoining the church is a building called the Sounding Aisle, from the wonderfully fine echo or reverberation of sound which takes place inside. On shutting the door suddenly the noise is intensified

to such an extent as to resemble a peal of thunder. The sound of a strong, deep voice is answered by as it were the roar of a lion. Singing, especially low, clear tones, and whistling, can be heard wandering away about the roof as if there were answering spirits hovering above.

Passing down to Renfrew, another ancient burgh, we are in the neighbourhood of Elderslie, where at least one tradition says that the patriot Wallace was born.

> "Yet bleeding and bound though her Wallace wight
> For his long-loved country die,
> The bugle ne'er sung to a braver knight
> Than Wallace of Elderslie."

Renfrew was an important place in early times, and was frequented by royalty. Robert II. had a palace here, and, as showing the condition of the river at these times, it is said that in the sixteenth century the burgesses of Renfrew had sixty boats employed fishing salmon. These fish, indeed, were so plentiful that the apprentices in the ancient and royal burgh made a stipulation that they were only to have a certain number of salmon dinners. Now, a railway-station, a steamboat wharf, and ship-building yards, are the most striking features which attract the eyes of the visitor. It may be noted that the building of dredgers is made a specialty here, all the newest improvements being introduced, so as more readily to scoop up and remove the dredged material from the river or bank. It is not only in our own river that dredging operations are carried on, but in many other rivers at home and abroad, and on the bars at their mouths, the iron bucket tears its way and brings up its spoil.

Inchinnan parish church stands a little below Renfrew, beautifully situated on a bend of the Gryfe close to its junction with the Cart. A religious house existed here so far back as in the year 1100; and in the graveyard several quaintly-carved old stones may be seen.

The following anecdote is told to show the effect on an upper Clydesdale man of the tidal action in the river here. "In the early part of last century the clergyman of Lamington, in the upper ward of Lanarkshire, had come to assist his friend, the incumbent of Inchinnan, on a sacramental occasion, travelling on horseback, and attended, according to the invariable practice, by his man, who, although from his vocation a severe critic of sermons, was profoundly ignorant of the doctrine of the tides. During the course of the visit the servant was astounded and alarmed to discover that the waters were moving in a direction the reverse of what he had previously witnessed; whereupon, concluding that some awful calamity impended, he hastened to his master's chamber, broke his slumbers, divulged the appalling phenomenon, suggested the prudence of immediate departure, and concluded by expressing a faint hope that they might yet reach Lamington in safety."—*Statistical Survey of Scotland.*

The water from Loch Humphrey in the Kilpatrick Hills is perhaps the largest addition for some distance on the north side, if we except the Forth and Clyde Canal, which empties itself at Bowling. The stream referred to was largely utilized some years ago by the mills at Duntocher erected there. A little above this village the stream crosses the line of the Roman wall, where an old

arch, probably of Roman origin, still carries the roadway leading to Glasgow by New Kilpatrick, and contains a stone with an inscription in Latin, which appears to be a copy from an earlier part of the structure. A mile or two lower down the river the small village of Milton is situated in a hollow almost beneath the shadow of the great basaltic hill of Dumbuck. This place, and Rothesay in the island of Bute, have the honour of being the first to start the cotton industry by power.

The Leven, also on the north side, is a short river, being the outlet of the waters of Loch Lomond. It is not now the stream of which Smollett wrote, as its banks are alive with various industries, such as dyeing, printing, ship-building, &c.

> "On Leven's banks, while free to rove,
> And tune the rural pipe of love,
> I envied not the happiest swain
> That ever trod the Arcadian plain;
> Devolving from thy parent lake,
> A charming maze thy waters make,
> By bowers of birch and grove of pine
> And edges flowered with eglantine."

Dumbarton, situated at the foot of its guardian Rock, has, like many other Scottish towns, a history stretching back to the rude and troublous times of centuries ago; thereafter, as the country quieted down, sharing in the manufacturing and commercial progress of the times, due to the enterprise and skill of its townspeople. At an earlier date it was noted for its glass manufacture; now the specialty is ship-building and marine engineering. The Dumbarton people appear early to have shown

skill in the ship-building line, as it is said that a ship was built here for King Robert the Bruce, who, after "life's fitful fever," died at Cardross in the neighbourhood.

Pennant says, "The Roman fleet in all probability had its station under Dumbarton; the Glota or Clyde has there sufficient depth of water; the place was convenient and secure, near the end of the wall, and covered by the fort of Dunglas; the Pharos on the top of the great rock is another strong proof that the Romans made it their harbour, for the water beyond is impassable for ships or any vessels of large burden."

From Dumbarton many fine steamers and sailing vessels have been launched into the Leven, and its various ship-building and engineering yards employ many thousands of workmen. And not only is the practical department of ship-building so well represented, but this town has the honour to possess a special feature, unique on the Clyde, viz.: a tank, erected by the Messrs. Denny in the Leven Shipyard, in which models of the various ships about to be built can be experimented upon, and the results for the ship obtained from the experiments with the model by means of the relations established by the late Dr. Froude, whose tank at Torquay has yielded so many results alike valuable to the ship-builder and the marine engineer.

From Pennant's tour we learn that: "After a long contest with a violent adverse wind, and very turbulent water," he passed under on the south shore, Newark, a castellated house with round towers, and reached Port-Glasgow. He says it is "a considerable town with a great

pier, and numbers of large ships, dependent on Glasgow, a creation of that city since the year 1608, when it was purchased from Sir Patrick Maxwell of Newark, houses built, a harbour formed, and the Custom-house for the Clyde established."

Port-Glasgow, with its many old-fashioned houses with crow-stepped gables, and its distinctive odour to the passer-by in the railway train of tar or oakum from the rope-spinning works, recalls the past times when there were few or no steam-boats and no electric telegraph, and the sailing ship was the great ocean carrier. The merchant in those days, after sending off his ship and cargo, could rest contentedly, so far as these possessions went, and was not worried, as his successor is at the present time, with swift passages and "wires" from all quarters of the globe. This town was originally called New Port-Glasgow, or shortly "Newport;" at least, Wilson, about 1764, refers to it thus:

> "Where, crowned with wood, fair hills embrace the bay
> Where Newport smiles, in youthful lustre gay."

Ground was originally feued here by the magistrates of Glasgow for a harbour for the shipping of the city. The Glasgow people had at first thought of Dumbarton and then Greenock as their port; but difficulties with the authorities of these independent burghs caused them to set up one for themselves, hence Port-Glasgow.

Greenock, like the larger commercial city further up the river, was but a comparatively small town about the middle of last century, the population at that time being under 4000. Looking at a map of the river and firth

published in 1760 by John Watt, junr.,[1] we see Greenock and the neighbouring town of Cartsdyke (now long since united) as each clustered round their quays or harbours, which project boldly into the river like bent arms, as if to welcome and secure the passing sail.

Greenock, according to Dr. Leyden in 1767, was a "thriving seaport, rapidly emerging into notice. In the beginning of last century it consisted of a single row of thatched houses, stretching along a bay without a harbour. In 1707 a harbour began to be constructed, but the town increased so slowly that in 1755 its population amounted only to about 3800 souls." In 1785 a dry-dock was built, and from time to time the harbour accommodation improved, so that about 1829, when the population amounted to about 27,000, the length of quays was over 700 yards. The Custom-house was erected in 1818 at a cost of £30,000, and with its handsome classic front has long been a well-known object to the steam-boat travellers up and down the river, and especially in the old days before the Princes Pier and Wemyss Bay routes were opened. Many a hurried, and perchance wearied, foot has trod the narrow and dirty lane which used to lead from the railway terminus to the quay, passing this fine edifice on the way. But not only has the march of improvement in railway service been going on, it has also passed over the quaint old crow-stepped gabled houses of this part of the town, and new buildings in all the glory of fresh

[1] This map is of great interest, and appears to have been published by John Watt, junr., a brother of the great James Watt, and nephew to the John Watt, senr., who made the survey for the map itself in 1734. It also appears that the map was advertised as on sale at the shop of James Watt, in the College of Glasgow, at the price of 2s. 6*d*.

ashlar fronts have arisen in their place. A few years ago a handsome group of buildings, with an elevated tower, were erected for the municipal work of the town.

In the *Statistical Survey of Scotland* we have the following curious extract:—

"In the *Literary Rambler* for October, 1832, there are some curious excerpts from a manuscript in the Advocates' Library, purporting to be a report by Thomas Tucker, one of Cromwell's servants, who was appointed to arrange the customs and excise in this country; from which we may form some conception of the state of commerce in Greenock and the neighbouring towns two centuries ago. The report is addressed 'To the Right Honourable the Commissioners for Appeals,' and is dated November 20th, 1656. After describing Glasgow as a 'very neate burghe towne;' all whose inhabitants were traders except the students, 'some for Ireland, with small smiddy coales in open boates from four to ten tonnes . . . some for France with pladding, coales, and hering.' And some venturing as far as Barbadoes, but discouraged by the loss they sustained, 'by reason of their going out and coming home late every year.' The reporter proceeds to describe the towns of Port-Glasgow and Greenock in the following terms: 'The number of ports in this district are, 1st, Newarke (Port-Glasgow), a small place where there are (besides the laird's house of the place) some four or five houses, but before them a pretty good roade, where all the vessells doe ride, unlade, and send their goods up to the river Glasgow in small boats; and at this place there is a wayter constantly attending. 2dly, Greenock—such another—only the inhabitants are more,

but all sea men or fishermen trading for Ireland or the isles in open boates. Att which place there is a mole peere where vessells in stresse of weather may ride and shelter them selves before they pass up to Newarke; and here, likewise, is another wayter.'"

Greenock, with a population of about 70,000, is a busy commercial centre. Ship-building, marine engineering, iron-foundries, and sugar-works, all combine to give employment to large numbers of work people. In busy times the smoke from the many tall chimneys, although indicating commercial activity, has quite an obscuring effect on the splendid landscape which opens out to the passer-by on the railways carried along the steep hill-sides above the town.

The Shaws Water-works, for supplying Greenock with water, were designed by Mr. Robert Thom, who had so successfully carried out the water-power required for the Rothesay cotton-mills, by laying various lochs under contribution, and regulating the supply in the various channels by self-acting sluices. Mr. Thom reported in 1824 on the Greenock supply, showing the great value of the power which could be obtained. Mr. Thom was so impressed by these advantages, that he says, "Here you would have no steam-engines, vomiting smoke, and polluting earth and air for miles round, to the no small annoyance and discomfort of the community at large, and to the unspeakable vexation and chagrin of gardeners, bleachers, and washerwomen." Mr. Thom afterwards says: "It is not to be inferred from this that I think lightly of the steam-engine. I merely wish to draw a little attention to another source of national wealth,

which (perhaps obscured by the dazzling blaze that has so long encircled the inventions of Watt) has been hitherto almost totally neglected. Such, indeed, has been the eclat of the steam-engine, that whenever a work became scarce of water, either from its being enlarged or from a dry season, nothing was to be heard but the general cry: 'Put up a steam-engine, and be independent of water.'" Mr. Thom, however, thought that the cry would soon change to, "Get water if you can, and down with your steam-engines." He, however, acknowledges the importance of his rival, especially for navigation, and concludes by saying, "Nor shall the name of the less fortunate inventor of the steam-boat be ultimately lost to fame, for although a thoughtless public should allow him to linger out the evening of his days in poverty, yet the time is coming when public meetings will be held and monuments erected to the memory of Henry Bell."

Harbours and docks present an inviting water-way and secure retreat for the various ships freighted with merchandise from all quarters of the globe, and from the fine esplanade carried along the shore to Fort Matilda a splendid view is afforded of the busy river, with its variety of shipping, the outward and inward bound Altantic liners at the Tail of the Bank, and the distant Highland hills beyond the Kilcreggan shore. The range of the tide at Greenock being small, from 8 to 10 feet, docks inclosed with locks or gates were not so much required as in ports having a greater range. Several of the docks or harbours are therefore open to the river.

Greenock, in its prosperity, has not forgotten the poor and the aged. A large and well-appointed building to

the west of the town, called Wood's Mariners' Asylum, was founded in 1850 by Commissary-General Sir Gabriel Wood, for the benefit of aged merchant master-mariners and merchant seamen, natives of the county of Renfrew and neighbourhood. Hospitals and Infirmaries, Charity Schools, a Seamen's Friend Society, homes for destitute boys and girls, and many other benevolent undertakings, all go to show that the present age, marked out as it is by the splendour of commercial success and scientific skill, is yet especially noticeable above the ages which have passed away as one of individual and public benevolence. Greenock has also several scientific institutions, one of which, the "Scientific Library," was founded by James Watt in 1816.

Chapter III.—GEOLOGICAL.

The Clyde rises from the northern border of the great Silurian rocks of the Southern Highlands, flowing along these until about Symington, where it enters the Old Red and afterwards the Carboniferous basin onwards to Glasgow. The Silurian system of the south of Scotland is described as follows by Professor Young: "The broad undulating district lying to the south of the Carboniferous basin of Central Scotland, and known under the general name of the Southern Uplands, is carved almost wholly out of rocks of Silurian age. The dominant formation is an immense series of comparatively barren graywackes and shales, which, thrown into innumerable folds and contortions, spread in an unbroken

sheet from St. Abb's Head to the Mull of Galloway, forming by far the grandest exhibition of Middle Silurian Strata yet discovered." Page, in his *Text Book of Geology*, says: "This system is largely developed in various countries, both in the Old and in the New World, and typically so in the district between England and Wales, anciently inhabited by the Silures; hence the designation 'SILURIAN SYSTEM' by Sir R. Murchison, their first and most ardent investigator."

The Clyde valley presents varied geological features, and offers a very good field for the study of this now important economical science. The rocks throughout are of the earlier and Carboniferous periods, seamed by dykes and capped by overflows of trappean rocks, indicating great changes of level and conditions in the past; whilst to the student of the glacial period abundant evidences of the presence of a great ice-sheet once more or less filling up the valleys, as the glaciers of Switzerland and Norway now do, may be met with in the boulders scattered about the lower levels, the great masses of boulder-clay, and the smoothed and striated rock surfaces which may still be met with. In reference to this it may be noted here that "A table-case in the Hunterian Museum contains a series of hand specimens, obtained by Mr. Young from the boulders which were removed when the summit of Gilmorehill was lowered for the foundation of the University. The series includes all varieties of rock from Bonawe to the Kilpatricks. The glacial striations of the district are generally from north-west to south-east."[1]

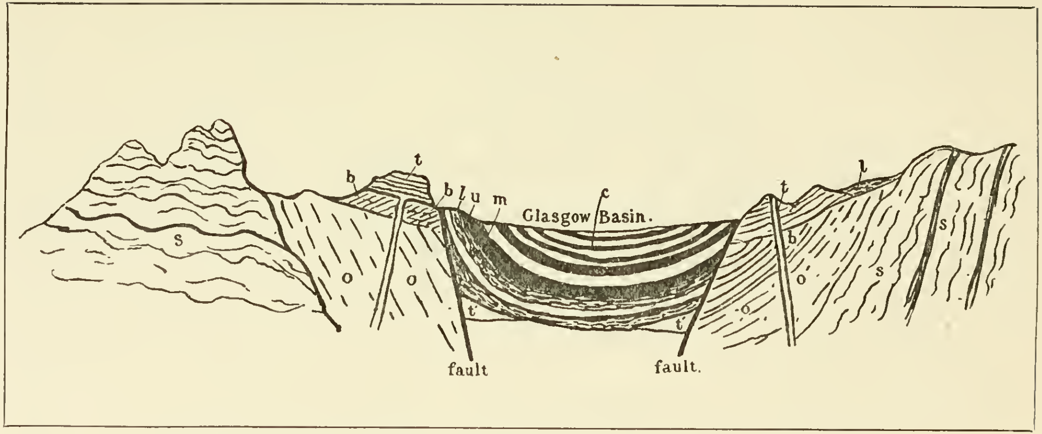
[1] Professor Young, M.D.: *Geology and Palæontology of the West of Scotland.*

If we take a sectional view of the country, in a line running north and south through the Clyde valley and passing through the Glasgow district, we find the Silurian rocks appearing to north and south, as a framework on which rests deposits of Old Red Sandstone, on which, in turn, rest the limestone, shales, and coal and iron beds of the Carboniferous period. Ejections of trappean rocks are frequently met with in the later deposits, troubling the miner by causing upthrows and downthrows.

The most widely-spread and most interesting series, in an industrial point of view, is the Carboniferous, covering all the middle portion of the Clyde valley, and extending to a depth of several thousand feet. The series consists mainly of beds of coal, iron-stone, shales, and fire-clay, with their accompanying limestones and sandstones.

The great "fault" already referred to as crossed by the Rotten Calder has caused the downthrow of the great coal-beds to a level with the lower deposits of the carboniferous limestone, shown in a geological map of the district by a sharp dividing line between the dark-coloured portion (the coal) and the bluish (the limestone). The amount of this displacement equals that of the thickness of the beds awanting, and has been estimated at about 1500 feet. Speaking of the limestones to the south of Glasgow Mr. Bell (*Rocks around Glasgow*) says:—

"They are also often called the 'cement limestones,' being largely used for cement and building purposes, as from a certain admixture of silica and alumina in their composition they have the property of 'setting' with a firm band under water. The Orchard limestone is



Geological Section from Grampians across the country near Glasgow to South of Scotland.

From a Drawing by Mr. John Young, F.G.S.

s s, Silurian. o o, Old Red Sandstone. b b, Ballagan Beds. t t, Bedded Trap. *l*, Lower Limestone and Coal. u, Upper Limestone and Coal. m, Millstone Grit. c, Upper Coal Beds. t′, Trap, downthrow.

wrought at a short distance to the south of Giffnock Quarries. It is also wrought as the 'Lyoncross' limestone at Nitshill and Barrhead, and is known as the 'Williamwood' limestone near Cathcart. It is only a thin bed, from 18 to 26 inches in thickness, but is of excellent quality, and has long been esteemed as a cement limestone. Underneath it is a thin seam of coal, which is used in calcining the stone. The Arden limestone, wrought extensively near Thornliebank and Barrhead, is in much greater mass, attaining a thickness of 8 to 10 feet, in some places even more. Its equivalent to the north of the Clyde, in the Garnkirk district, is largely used for iron-smelting."

The varieties of coal, and varying condition and thickness of the limestone and sandstone beds, all point to long periods of land surface, with correspondingly extended periods of depression under the surface of the water.

Professor Geikie, in his *Scenery of Scotland*, thus graphically describes the Clyde valley:—

"While the three main rivers resemble each other in thus breaking through a chain of hills to find their way into their firths, they present many points of difference in their respective courses across the lowland valley. Perhaps the most interesting is the *Clyde*. Drawing its waters from the very centre of the southern uplands, it flows transverse to the strike of the Silurian strata, until entering upon the rocks of the lowlands at Roberton it turns to the north-east, along a broad valley that skirts the base of Tinto. If the reader will glance at the map he will notice that at that part of its course the Clyde ap-

proaches within seven miles of the Tweed. Between the two streams, of course, lies the watershed of the country, the drainage flowing on the one side into the Atlantic, and on the other into the North Sea. Yet, instead of a ridge or hill the space between the rivers is the broad flat valley of Biggar, so little above the level of the Clyde that it would not cost much to send that river across into the Tweed. Indeed, some trouble is necessary to keep the former stream from eating through the loose sandy deposits that line the valley, and finding its way over into Tweeddale. That it once took that course, thus entering the sea at Berwick instead of at Dumbarton, is probable; and if some of the gravel mounds at Thankerton could be re-united it would do so again. Allusion has already been made to this singular part of the water-shed. Its origin is probably traceable to the recession of two valleys, and to the subsequent widening of the breach by atmospheric waste and the sea.

"From the western margin of the Biggar flat the Clyde turns to the north-west, flowing across a series of igneous rocks belonging to the Old Red Sandstone series. Its valley is there wide, and the ground rises gently on either side into low undulating hills. But after bending back upon itself, and receiving the Douglas Water, its banks begin to rise more steeply, until the river leaps over the linn at Bonnington into the long, narrow, and deep gorge in which the well-known falls are contained. That this defile has not been rent open by the concussion of an earthquake, but is really the work of sub-aërial denudation, may be ascertained by tracing the unbroken beds of lower Old Red Sandstone

from side to side. Indeed, one could not choose a better place in which to study the process of waste, for he can examine the effects of rains, springs, and frosts in loosening the sandstone by means of the hundreds of joints that traverse the face of the long cliffs, and he can likewise follow in all their detail the results of the constant wear and tear of the brown river that keeps ever tumbling and foaming down the ravine."

Chapter IV.—HISTORICAL.

Burton in his *History of Scotland* says: "It is in the year 80 of the Christian era that the territory in later times known as Scotland comes out of utter darkness and is seen to join the current of authentic history. In that year Julius Agricola brought Roman troops north of the line, which, hundreds of years afterwards, became the border dividing Scotland from England. . . .

"The neck of land between the Firths of Clyde and Forth appears to have been the boundary where the general found that the outer line of Roman acquisition could be most effectually marked. Agricola ran defensive works across this line; and these were the beginning of the fortified rampart, renewed and strengthened from time to time, of which some remnants may still be seen."

Agricola for five years remained in the country establishing forts and making occasional campaigns, gradually pushing northwards until the famous battle of Mons Grampius was fought, somewhere probably north of the Tay, but authorities are divided on this, as upon many

other matters of these far-back times. Agricola appears to have been a skilful general as well as military engineer, as his forts were numerous and well planned. In A.D. 85 he was recalled by orders from head-quarters, it is believed through envy at his success. The chain of forts which he erected from the Forth to the Clyde, after subduing the tribes to the south of the latter river, gave him a base of operations from whence he proceeded in his more northern and last campaign. The tribes to the north of this line appear to have been the Caledonians, or Picts as they were known later on, a race of a warlike character. Thus we are told by a Roman historian, Dion Cassius, that "they have neither castles nor cities; nor do they till the ground, but live by their flocks, by hunting, and on the fruits of trees. They go naked and dwell in tents. They are addicted to plunder, make war in chariots, and have small but fleet horses." He further tells us that they are armed with a shield and short spear, and carry short daggers. This description applies to the "two great nations, the Caledonians and Mæatæ;" the latter, however, were said to "dwell near the wall which divides the island into two parts, and beyond them are the Caledonians."

These impetuous natives, on the retreat of the Roman army southwards and the absence of Agricola, descended from their "rugged and arid mountains, and desert plains abounding in marshes," and made reprisals, carrying with rapid and fierce attack the Roman forts and driving back their legions. The Emperor Hadrian, however, visited Britain (A.D. 120), and determined to make a division further south, so as to protect the Britons who had become

Romanized from the Caledonian tribes of the north, and consequently built a wall extending from the Tyne to the Solway. This no doubt served the purpose to some extent and for a time, but the Romans had a valiant, restless people to deal with, who paid little respect to the warlike emissaries of the Mistress of the World. Hence about A.D. 140 Lollius Urbicus, a lieutenant of the Emperor Antoninus, was sent to deal with the refractory tribes who lived to the north of Hadrian's Wall, in which he seemed to be successful, as he appears to have penetrated as far north as the Moray Firth. Lollius, like Agricola, believed in having a base of operations to operate against the Caledonians of the north and the inhabitants of the country to the south, as he completed the line of defences begun by the latter general, and built a wall from the Forth to the Clyde pretty much on the line of Agricola's forts.

The northern tribes appear to have highly resented this abridgment of their liberties, and made constant efforts to overturn the Roman power. They were finally successful in bursting through this new barrier, and apparently did not stop until they had passed through the more southern wall of Hadrian. For a time they appear to have held this territory, harassing the provincial Britons of the southern part of the country, and levying "blackmail" on these more wealthy and probably more peaceful tribes. Such a state of things did not suit the central authority at Rome, and about A.D. 208 the Emperor Severus came to Britain to look into matters in person, and subdued the tribes once more with his legions. The passion for building walls still existed as strongly as

ever, and Severus built another somewhat on the line of Hadrian's.

For about two hundred years after little is known of the events happening north of this wall. About the year 306 the restless Caledonians seem again to have made an excursion south, only to be driven back by the Romans, who, still believing in their walls, had the one between Forth and Clyde put in complete repair, and added to its strength about the year 368. The district lying between the walls was known to the Romans as the province of Valentia. The Romans finally abandoned the district about the year 446, and their ancient foes of the north were not long in following up this advantage, and renewing their raids upon their neighbours to the south. Those tribes formed themselves into a community for purposes of defence, from which arose the Cumbrian or Strathclyde kingdom, of which what we now call Lanarkshire constituted a portion. Mr. M'Gregor, in his *History of Glasgow*, says:

"Running through this early British kingdom was the now famous river Clyde, a name derived with little or no alteration from the old British or Welsh word *Clyd*, signifying *warm* or *sheltered*. Even in these primitive days Clydesdale was celebrated for its fruit crops, for there is an obscure reference by one of the early chroniclers to the 'orchardes of Lenerck.' The metropolis of this region was Alclwyd, or Petra Cloithe (Rock of the Clyde), afterwards called by the Scoto-Irish Dunbritton (Hill of the Britons), from which, by an easy transition, comes the present name of Dumbarton."

Speaking of these occurrences, Burton says: "Cumbria

or Cambria was the name given to the northern territory retained by the Romanized Britons, a territory described as a continuation northward of their Welsh territory. Gradually, however, the name of Strathclyde was given to that portion reaching from the Solway northward, in fact the portion within modern Scotland. The word Cumbria continued to be frequently used as equivalent to Strathclyde."

The walls built by the Romans appear to have been much the same in design, that is to say, they consisted generally of a wall with a ditch. In the case of the earlier works the material used was mainly earth, stones being placed where the foundations were to be on marshy ground. The later wall raised by Severus was largely composed of stone, with towers at intervals. The wall between the Forth and Clyde appears to have had a *vallum* or ditch of from twelve to fifteen feet wide, and the earth taken out was used to make the *agger* or wall, the latter being raised on the south side. A military road or causeway adjoins this work. From inscribed stones found on the line of this wall we find that a great part of it was executed by the Legio Secunda Augusta, and it is thought, from the skill and celerity with which the Roman legions executed such defensive works, that although the length is about thirty miles, yet it might be finished in a few months.[1]

[1] "Perhaps no part of Britain has been the scene of so many sanguinary conflicts as the vicinity of the Roman Wall.

"The Romans and the Caledonians, the Southern and Northern Britons, the Saxons, the Picts, the Welch, and the Scots, had all fallen on these fields before the plains of Falkirk and Bannockburn were whitened with the bones of the more modern English and Scots. 'The sore battaile of Camlan,' in which

The line of this wall can still be readily traced at parts, and at the stations made out. Recently a portion of the wall and military way was exposed in some excavations at Kirkintilloch.

Many sculptured stones and objects of interest, of Roman origin, have been discovered from time to time in the line of the wall and in the Clyde district, and are now preserved in the Hunterian Museum. Not many years ago a fine bowl of Samian ware was dug up in Glasgow Green, and is now preserved in the Kelvingrove Industrial Museum. This bowl is supposed to date back to near the beginning of the Christian era, and may have at one time in other lands served at the banquets of the great, when the order was given to

"Fill high the bowl with Samian wine!"

On the parish church of Baldernock, a few miles to the

Arthur and Modred fell, was probably fought in the same vicinity. The following passage of an old romance presents a vivid picture of one of these battles:—

"King Bohort so smot ozan,
O the helme that hoge man,
That he sat astoned uprizt,
& nist whether it was dai or nizt—
—Ichon other so leyd beir,
That it dined into the air;
Also thicke the aruwe schoten,
In sonne bem so doth the moten;
Gaue lokes al so thick flowe,
So gnattes ichil avowe.
Ther was so michel dust riseing,
That sen ther was sonne schineing;
The trumpeing and the taburninge
Dede togider the knitztes flinge."

—*Leyden's Notes to Wilson's "Clyde."*

north of Glasgow, and not far from the line of the Roman wall, is a stone with the following Latin inscription:

DEO . OPTIMO . MAXIMO ! P. FS - QS. MD, CCXCV.

The year mentioned is the date when the present church was built, an earlier edifice having stood upon the same site. In Dr. Bruce's description of Hadrian's Wall a stone is described having an inscription almost similar so far as the three first words are concerned, but with Jove as the deity addressed. The similarity suggests a Roman origin for the stone, or at least for the form of the dedication.

The Rev. H. R. Haweis, in *The Light of the Ages*, says: "The Romans had no special cosmogony—no favourite gods—everyone was allowed to bring his own—all seemed welcome, all were equally accepted by the state, which, if it gave any theological unity at all to the national Pantheon, only did so by a rather misty assertion of the general supremacy of Jupiter Optimus Maximus."

The withdrawal of the Romans did not, however, leave the natives in undisturbed possession of their territories, as about the middle of the fifth century the Saxon element asserted itself in the south-eastern part of the country, and about the year 500 the Scots settled in Argyle. These Scots were also known as Dalriads, their original territory having been the northern part of Antrim. Here, then, we see the country nearly divided amongst four different peoples, all of whom appear to have been actuated by an aggressive spirit. Consequently they were in incessant commotion, which was heightened at a later period by the inroads of the Norsemen.

About the year 685 a great battle appears to have been fought at a place called Dun-nechtan or Nechtans Mere, north of the Tay, between the Northumbrian Saxons who had invaded the country and the Picts, in which the latter were victorious. This battle appears to have had a greater importance than many of the other struggles in which these various tribes were engaged. Thus Burton in his *History of Scotland* says: "The Saxon army was destroyed; the frontier of the Forth was abandoned; and the Kingdom of Northumbria, taking its limits at the Tweed, foreshadowed the boundary line between the England and Scotland of later times."

About this time Great Britain appears to have been divided broadly into four nationalities. The ancient Britons, who had still preserved something of their original characteristics notwithstanding the four centuries of Roman occupation, were distributed more or less along the western coast throughout Cornwall, Wales, and Cumbria. The Saxons, who, having been invited by these Britons to help them oppose the Roman power, preferred to remain on the island, and spread themselves over a great part of England and the east of Scotland. The Picts, who still held their own against all comers, appear to have inhabited the country to the north of the wall between Forth and Clyde; and the Scots were established in the West Highlands. The struggle for existence went on; the Picts and Scots struggling over long years for the mastery, until finally a union resulted in 843 under Kenneth II., King of the Scots.

During those early times the Strathclyde Britons must have been more or less affected by the movements of their

active and predatory neighbours. The territory spoken of as Strathclyde appears to have embraced Ayrshire, Renfrewshire, Lanarkshire, Stirlingshire, and Dumbartonshire (in which latter shire the capital was situated), and they appear to have preserved an independent existence till after the union of the Picts and Scots; after that event it became incorporated with the larger state about the time of Kenneth III. or Malcolm II. The latter prince appears to have been an able general, and extended the boundaries of the now rising kingdom of Scotland. In this he had to contend both against the Northumbrians and the Danes; the latter sea-rovers having for some time infested the coast both east and west.

A few years afterwards, in 1039, the then reigning King Duncan was slain by a northern chieftain, whose name and deeds live again in the tragedy of *Macbeth*, who himself fell in a fight with Malcolm, a son of Duncan, the latter being proclaimed king:

> "Hail king! for so thou art; behold, where stands
> The usurper's cursed head: the time is free;
> I see thee compass'd with thy kingdom's pearl,
> That speak my salutation in their minds;
> Whose voices I desire aloud with mine,—
> Hail King of Scotland."

This Malcolm, surnamed Canmore, reigned for thirty-six years, and married Margaret, a Saxon princess and sister to Edgar Atheling, the heir to the Saxon line in England. He was an able prince, who upheld the position of the now growing country of Scotland against its foes, and died in battle against the Normans at Alnwick Castle in 1093. Passing over the short reigns of Donald Bane,

Edgar, and Alexander I., we find David, the youngest son of Malcolm Canmore, succeeding to the throne in 1124. He did much for the improvement of the country both commercially and ecclesiastically, and died in 1153 after reigning twenty-nine years. The succeeding reigns of Malcolm IV., William, and Alexander II., until that of Alexander III., are more or less marked by struggles for the consolidation of the regal power or extension of the same.

The seaward portion of Strathclyde must have now suffered much from the incursions of the Norse sea-rovers, as from time to time their ships entered the firth and their warlike crews threw themselves upon the country with the suddenness and celerity of sea-birds. These adventurous strangers carried on their raids for the long period of eight centuries, and especially along our north-eastern and north-western coasts have left many traces of their inroads and occupation. They have doubtless contributed much of the sea-blood in our stock, as the earlier races do not seem to have been distinguished by nautical enterprise.

Motherwell, a Glasgow poet (1797–1835), gives us the following stirring song of the Danish sea-king:

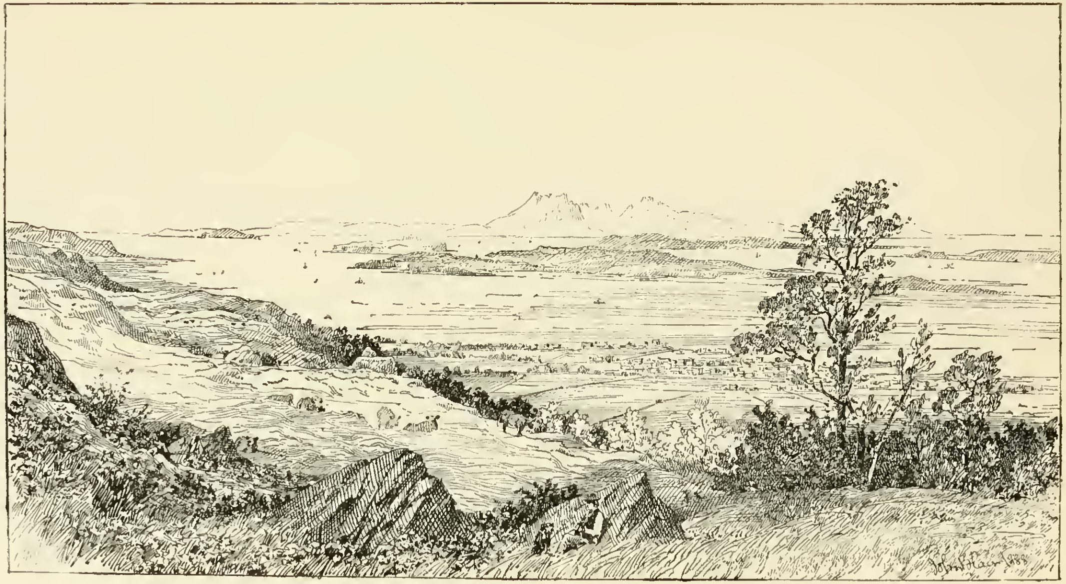
"Lords of the wide-spread wilderness of waters we bound free,
The haughty elements alone dispute our sovereignty;
No landmark doth our freedom let, for no law of man can mete
The sky which arches o'er our head—the waves which kiss our feet.
The warrior of the land may back the wild horse in his pride;
But a fiercer steed we dauntless breast—the untamed ocean tide;
And a noble tilt our bark careers as it greets the saucy wave,
While the herald storm peals o'er the deep the glories of the brave."

The reign of Alexander III. is marked especially by a

determined attempt of the Norsemen under King Haco, who with a large fleet entered the firth in 1263, and attempted to land his forces at or near where the town of Largs now stands. It appears that the cause of this attack on the Scottish kingdom was the question of the sovereignty of the Western Islands. The circumstances of this early battle seem remarkably like in many respects those which accompanied the attack on the shores of England in the reign of Elizabeth. In both cases a violent storm interfered with the plan of attack by disabling part of the attacking fleet. The battle of Largs, however, was in no case a sea-fight; it was more an attempt at invasion of the country with a large army conveyed in sailing vessels, as the Normans had done at Hastings nearly two hundred years before.

The storm burst upon the Norsemen, and King Haco could only land a part of his forces. These were routed by the Scots. Afterwards some more of the scattered fleet landed their contingents, and the battle was renewed and carried on for a whole day. But the victory was not for Haco. The forces of nature and the determination of the Scottish warriors were too much for the valour of the sea-rovers, who were at length finally beaten off to their ships. With a military courtesy which one would hardly have expected in that rude age the Norsemen were afterwards allowed to bury their dead on the field of battle, and many cairns and tumuli still, or until recent years, stood near Largs as silent memorials of that eventful day in our history.

From the higher slopes we can still view the main features of the scene as they appeared when—



View of Firth of Clyde from above Largs—Arran in the distance.

"The King of Norse in summer tyde,
Puff'd up with pow'r and might,
Landed in fair Scotland, the isle
With mony a hardy knight.
The tydings to our good Scots king
Came as he sat at dine,
With noble chiefs in brave array,
Drinking the blood-red wine."

King Haco drew off his shattered forces, and hied him away back to Norroway; but his proud heart could not bear defeat, and he died at Orkney.

Carlyle in his *Early Kings of Norway* says: "To this day, on a little plain to the south of the village, now town, of Largs, in Ayrshire, there are sandstone cairns and monumental heaps, and, until within a century ago, one huge, solitary, upright stone, still mutely testifying to a battle there,—altogether clearly to this battle of King Hakon's; who, by the Norse records too, was in these neighbourhoods at that same date, and evidently in an aggressive, high kind of humour."

In these early days the kingdoms or districts of Northumbria and Cumbria appear to have stretched side by side from the Forth to the Humber on the one hand, and from the Clyde to the Mersey on the other; almost dividing the country in a north-and-south direction equally between them, the dividing line following somewhat the main watershed of the country.

The ancient kingdom of Strathclyde comes into prominence, amidst the confusion which surrounds a great deal of the history of these early times, through the labours of Kentigern, or, as he is better known, St. Mungo. Born about the middle of the sixth century, he is supposed

to have established himself as a religious recluse in a cell on the banks of the Molendinar, latterly establishing a church in the district, where, some think, the Romans had a station, and which may be considered as the point around which the city of Glasgow gradually developed itself. St. Mungo died about the year 600, and tradition says he was buried on a spot near where the eastern end of the present cathedral now stands.

About the same time (560) Columba established his religious community in Iona, and it is said he afterwards visited Kentigern in his district. Many stories have come down to us of St. Mungo's piety and miraculous power; and doubtless he would, like Columba, exercise considerable influence on the wild tribes amongst whom he dwelt. In speaking of Strathclyde, Burton says: "Strathclyde has less renown from its political history than as the theatre of the triumphs of St. Kentigern."

Both in a religious and social aspect little is known of the condition of the people in these early times. The early religion of the people, according to references by Roman writers, appears to have been Druidism; but as to its essential characteristics, we are left much to speculation. The habitations appear to have been formed in some cases of branches or twigs and clay, as Columba's early dwellings are recorded to have been. The remains of lake-dwellings, founded on piles driven into the water, stone towers or brochs, and earth-houses, are left for the antiquary to investigate and unravel their use and purpose as best he may. The part of the country held by the Romans would soon show the skill and taste of that nation of builders, and the Romanized inhabitants would

no doubt learn some of the lessons taught them by the buildings which were erected.

The Druid performed his mysterious rites in the gloom of the forest, and the Roman soldier raised his altar to one or other of his mythological heroes, and to the mighty Jove. In an article on "Ancient Tumuli," in *The Scots Mechanics' Magazine*, 1825, it is stated that "On Dychmount Hill, near Glasgow, which is situated in the centre of the Rutherglen and Cathkin tumuli, a thick stratum of charcoal has been discovered, which has lain concealed for time immemorial under a stratum of fine loam near the summit of the hill; and that on seeing the charcoal for the first time the country people expressed no surprise, because the tradition was familiar that their forefathers had been in the habit of lighting the Beltane on the summit of this hill. The Beltane is generally believed to have derived its appellation from the divinity Belus, or Bel of the Babylonians, who is supposed at some distant date to have had his worshippers in our island." It was a rude age, the people restless and ever engaged in struggles either for their daily food—whether with the wild beasts which then roamed through the forests, or with a soil whose return was as yet scanty and limited from the want of skill of the agriculturist—or, again, in contention with their neighbours for the mastery over the lands which stretched around.

Whatever Christian influence there may have been, and which might have entered during the later part of the Roman occupancy, does not seem to have been marked. It was a most unpromising outlook in many

ways for the mission of such men as Columba, Kentigern, and Aidan. Yet these men, by calm perseverance over the many difficulties which surrounded them, by the purity of their lives and the force of a noble example, inspired by a high religious purpose, where Christian gentleness was opposed to all the rough and warlike energy which dwelt in those to whom their mission was addressed, slowly gained an influence over the various districts in which they laboured, sowing a seed for good which, with many changes during the long course of the ages, has yet sprung up and grown and increased, we now reaping the fruits of their labours.

Speaking of this, Dr. Ross says:[1] "During the long period of eight centuries that elapses from the departure of the Romans to the War of Independence, some shining figures light up the deep obscurity in which Scottish history is involved. Of contemporary literature there was, unfortunately, little or nothing, and the lives of men like Ninian, and Kentigern, and Columba have come down to us with halos of imaginative superstition that make biographical criticism well-nigh impossible."

And as bearing upon this subject, and showing the condition of the people inhabiting the district of the Tyne, we have the following in a work on the river Tyne by the late J. Guthrie:—"During the long dark night which ensued on the cessation of the Roman power, and the establishment of the Saxon dominion, we get no glimpse of the Tyne, nor, indeed, of anything certain in English history. Fearful and bloody inroads of Picts and Scots, arriving shoals of Angles, Jutes, and

[1] *Scottish History and Literature*, by John M. Ross, LL.D.

Saxons, with their murderous warfare on the ancient inhabitants the Britons, is what we know to have taken place; and when, after this darkness of a century and a half, history again throws a dim light on the scene, we find the district forming part of the sometimes dual, and sometimes united, Saxon kingdom of Northumbria. Under the Northumbrian kings Christianity is again introduced among the pagan inhabitants by Paulinus from Kent and Aidan from Iona. The foundations of the great see of Durham are laid by Aidan in the church formed at Lindisfarne, or Holy Island. The monastic system is established and rapidly spreads. Churches and monasteries are founded at Monkwearmouth and Jarrow, and we find the old Pons Ælii, the military station of the Romans, referred to by the appellation of Monkchester. The Cathedral of St. Wilfrid, now the Abbey Church of Hexham, is erected. The stately and beautiful Priory of Tynemouth rises through the piety and munificence of Northumbrian kings, who endowed the place with princely gifts. The earliest religious house is said to have been founded at Tynemouth by King Edwin, and church of stone first built by King Oswald."

Writing on "The Early Christianity of Northumbria," the late Dean Stanley (see *Good Words*, 1875), speaking of the two sources from which Northumbria was Christianized, says: "At the end of the sixth century, when the first Italian missionaries landed in Kent, Northumbria had, as far as we know, remained more completely beyond the reach of the Christian religion than Southern or Western Britain. We hear of the first British martyr,

St. Albyn, in the southern provinces; but there is no story of any such martyr in the earlier days of Northumbria. We hear of the first British missionary, St. Ninian, on the coast of Cumberland, in the fourth century, and on a lonely hill in Galloway still survives the contemporary gravestone of some who would seem to have been his own companions." He then speaks of the advent of Paulinus. A stagnation in the new religious life afterwards followed, and Aidan from Iona was sent. "He started on the long journey over highlands and lowlands, and did not pause till he came to a spot which reminded him of the distant island home that he had left on that western coast of Scotland. This spot was Lindisfarne, which, from his settlement there, became the Holy Island in his eyes, and in the eyes of those that followed him, even as Iona had been before."

When we see across so many centuries the use to which King Oswald turned the irregular bands of Irish and Scottish missionaries to fill up the vacant spaces which Edwin and Paulinus, with their more statesman-like and established order, had left unoccupied, we can now see clearly that without some such co-operation Christianity might have died out from the old kingdom of Northumbria, and generations would have been lost to the Christian civilization of England.

Of St. Ninian we are told (*History of Stirlingshire*, 1817) that "The Romanized Britons of Valentia, who, by Bede and the contemporary writers of the middle ages, are called the Southern Picts, were converted, about the beginning of the fifth century, by Ninian or Ringan." He appears to have been born in Scotland about the

year 360, and founded a church at his birthplace, Whithorn, which, being built of stone, was called *Candida Casa.* Ninian died in the year 432, and the day of his death appears to have been long celebrated, and his name associated with many places throughout Scotland.

It is usual for archæologists to speak of the Stone, Bronze, and Iron ages, and doubtless the earlier inhabitants of the Clyde valley would have methods of living, and implements alike primitive. Their early vessels in which they moved about in the then wide estuary, which must have stretched across the valley where the city of Glasgow now stands, do not show any special marks of skill, as the various canoes which have been found in the sandy substratum of our now busy thoroughfares are simply "dugouts." We must not, however, suppose that because the races which inhabited a certain tract of the earth's surface were of a low type, that therefore all its inhabitants were in a like condition. Doubtless the various developments overlapped each other, as they do at the present day, when our high civilization is often contemporary with very primitive habits.

Chapter V.—THE CITY OF GLASGOW.

Glasgow is the centre of wide and varied industry. The great coal and iron fields of the neighbourhood have afforded unlimited scope for the enterprise of the Middle Ward to develop itself in the form of coal-mines, blast-furnaces, puddling-furnaces, rolling-mills for iron and steel manufacture. The sandstones have been quarried

for the buildings which now stretch for miles in all directions around the old historic centres of the Cathedral and the Cross. The application of chemistry to the arts has developed many and special branches of products, the tall chimney of St. Rollox being a memorial to the foundation of several notable industries, viz. the manufacture of soda, soap, and bleaching-powder.

The introduction of steam-power, and the improvement of the spinning and weaving appliances, caused the construction of cotton and other mills;[1] while the great shipbuilding and engineering industries of the Clyde, from very humble beginnings in 1812, have developed and flowed onwards like their parent river in ever-widening volume. The rise of many of these industries is of comparatively recent date; some which at one time flourished have largely disappeared, whilst other and newer forms have taken their place. Glasgow, fortunately, is many-sided in this respect, and therefore not so much affected by times of depression as are other cities which depend upon a few special processes of manufacture.

In earlier days the productive operations were carried on mainly for home consumption, and the produce would be bargained for on a large scale at the various fairs held during the year; a survival of the name only now remaining in the "Fair Week" and "Fair Saturday," well known to Glasgow citizens as a period of recreation. Then the commercial activity relaxes, the clank of the steam-engine is hushed, and the black smoke from its accompanying boiler-chimney is scarcely seen. This is

[1] The first power-loom experiments were made in the Gallowgate, and the first really practical work was done at Milton, near Dumbarton.

the time for a stranger to visit the city, if he wishes to get some idea of its extent and the character of its architecture, as then the almost smokeless atmosphere will offer little impediment to his inquiring gaze.

The most notable export in early times appears to have been the natural product of the river and the firth, as we find that in the fifteenth century salmon was exported, and later in the seventeenth century both salmon and herrings were cured and exported to France; brandy, wine, and salt being returned as imports.

The union of the Scottish and English crowns took place in 1603, when James VI. of Scotland ascended the throne of England; but it was not till the union of 1707, when the parliaments were united, that any special commercial benefit was felt by Scotland. After that union a great stimulus to commercial enterprise was obtained in the new fields opened up by the colonial trade being thrown open to the energy of the Clydesdale merchants.

The "Tobacco Lords" rose and flourished in the Virginia trade, and walked the "plainstanes" at the Cross with great importance, dressed in rich attire even in business hours:

> "When on the 'Change the gay-drest merchant shines."

The American war put an end to this colonial trade, so that about the year 1775 new fields of enterprise had to be looked for and opened up, and the great cotton industries were started, together with dyeing and the printing of cloths.

Pennant tells us that when he visited Glasgow in 1772 there were carried on quite a variety of industries, such

as linens, cambrics, lawns, fustians, tapes, striped linens, sugar-refining, glass-making, rope-spinning, shoes, boots, and saddles. Speaking of the latter he says: "The Magazine of Saddles is an amazing sight; all these are destined for America." One wonders now what became of the stores in this "magazine," as about that time the disputes were just arising which led to the war being declared in 1775, and the blockade-runners of the eighteenth century would hardly equal in speed those of the nineteenth. It is somewhat curious to find that at that time there was "a great porter brewery which supplies some part of Ireland." The export of coals was also going on to the same country and to America.

In speaking of the origin of the foreign trade of Glasgow, Pennant says it was due to a Walter Gibson, who, in 1668, cured and exported in a Dutch vessel about 1800 barrels of herrings. These herrings went to France, and the return was brandy and salt. The profit on this venture enabled the enterprising merchant to buy vessels for himself, with which he traded to Europe and Virginia. He even imported iron and wine; previously to that Glasgow depended for those commodities on some of the other Scotch towns. M'Ure, in his quaint *History of Glasgow*, published 1735, tells us that "Walter Gibson, eldest Son of the deceast John Gibson of *Overnewtoun*, Merchant and late Provost of Glasgow, his first appearance was in malt-making, and his stock being improven that way, he left that trade, and betook himself to merchandizing, and began first with the herring-fishing." He appears to have been Provost of Glasgow in 1687. After all this Pennant remarks: "Yet I find no statue,

no grateful inscription to preserve the memory of Walter Gibson."

In the early centuries of our era the rise of centres of life and energy, which we now designate towns and cities, appears often to have been due to one or other of two causes, viz. religion or war. In the one case the influence from the cell of the recluse became like a light shining in the darkness, and penetrated the obscurity which lay around, gradually spreading until communities were formed, moved more or less by united aims. In the other case, especially later on in feudal times, the strong castle of the baron gave shelter and protection to those who acknowledged his sway, and were prompt to defend and further his interests.

Glasgow appears largely to have originated in the former of these causes. Kentigern placed his cell on the banks of the Molendinar, and the collection of huts which at one time must have grown around this centre of light and leading gradually took upon itself the form of a town, and in gratitude to the early recluse adopted him as its patron saint under the designation of St. Mungo. The religious aspirations of the young town and growing city showed themselves in the motto which the early rulers chose to accompany the arms: "Let Glasgow flourish by the preaching of the Word."

According to Mr. Macgeorge it was towards the close of the sixteenth century that armorial bearings were used by Glasgow, and from that time till about twenty years ago great variety appeared in the forms used, until it was authoritatively settled at the request of the magistrates by the Lord Lyon in 1866. A seal was used in

early times which appears to have exhibited the leading features shown afterwards on the city arms, these being the head of St. Mungo, the bell, fish, bird, and tree.

Mr. Macgeorge, in further speaking of the motto, "Let Glasgow flourish," says that it is first met with on the bell of the Tron Church, of date 1592, an inscription on which reads, "Lord, let Glasgow flourish through the preaching of the Word and praising Thy name." This, however, was only an ecclesiastical motto, and it was not till 1699 that it appears in the heraldic form upon the city arms; but in this case again it is still connected with a church (the Blackfriars in High Street), where it simply reads, "Let Glasgow flourish." This motto was afterwards confirmed in 1866 by the Lord Lyon King of Arms.

St. Mungo, or St. Kentigern as he was at first called, is so associated with the early history of Glasgow, that both in records of a historical and fabulous character we find frequent reference to him in the earlier traditions of the city. He was the

> "Prophetic seer, whose visionary eye,
> Saw Glasgow's glory in the future lie."

St. Mungo appears to have been one of the early Culdee monks, and selected the banks of the Molendinar for the site of his cell. About 580 he appears to have founded a church in the rising village or town of Glasgow, where he died about 601, his tomb being still shown in the crypt of the Cathedral which bears his name, and which rose in later years (1123), on or near the site of his early abode. The passing years brought with them many

changes; one not the least important in the civil life of the town was the increased power of the clergy, as we read that a castle was afterwards built for the bishop close to the Cathedral. This castle, or episcopal palace, was removed in 1791 to make way for the Royal Infirmary, which now occupies the site.

The legends relating to St. Mungo's powers are many and various. Some have been associated with the arms of the city. "The Legend of Saint Mungo" is told by "Keelivine" (the late A. D. Robertson) in verse, who says:—

"He was the gentlest of his kind,
Beloved by grit and sma';
A welcome guest where'er he gaed
In cot-house or in ha';"

the poet then makes a beautiful and quaint reference to the robin of St. Mungo's former master St. Servanus or St. Serf, which he when a boy had restored to life:

"He lookèd east, he lookèd west,
His hand on his ee-bree,
He lookèd north, he lookèd south,
There Clyde flow'd to the sea.

Nae signal-fires[1] on Tintock blazed,
Or Deichmont's sacred height,

[1] The signal fires referred to were common in the days of old before the railway and electric telegraph had entered the field as swift messengers of news. The Jubilee Year of our Gracious Majesty Queen Victoria, however, saw many a beacon glowing on the mountain tops on the fiftieth anniversary of her coronation, and so, although now commemorating a happy and peaceful event, we were enabled to form some idea of the appearance of the country in far-back times when invasion was expected, as on the approach of the great Armada to our shores just three centuries ago, when the country was roused by beacon lights from the southern coast.

Nae smoke arose frae Cathkin Braes
  To vex Saint Mungo's sight.

'But hark ye weel, my bonny bird,
  Upon the tree sae high,
Was that the curlew's distant call,
  Or lapwing's warning cry?

'Or was it, what I weel mot guess,
  The sough of angry men;
Or but the burnie's playful sang,
  That wimples down the glen?'

The birdie flew a mile about,
  A mile but barely three,
O'er howm and height wi' steady flight,
  To see what he could see."

The bird on returning tells Saint Mungo amongst other things that

"Thy prayer has quench'd the Beltane fires,
  For helpless victims laid;
And furious priests shout for revenge
  On thy devoted head."

After many enterprises in which the saint was engaged in calming the troublous spirits of the times, the author finishes by saying:

"While Christian truths Saint Mungo taught
  His people to discern,
And under God that gentle saint
  Was hailed as KENTIGERN."

OLD GLASGOW.

When a stranger visits a large town or city he is generally desirous of having a comprehensive view of its extent and the character of its buildings. Some cities from their

natural position are better suited than others for affording the visitor a variety of bird's-eye views, which combine instruction with picturesque effect. Edinburgh is notable in this respect, and has for long afforded the visitor a great and lasting pleasure in the splendid views which can be obtained from the many elevations in and around the city.

Where, however, the natural features do not offer these advantages, the visitor usually betakes himself to the summit of some high building, where he can have an uninterrupted outlook on the whole city. In this way, combined with a closer examination of the places of interest and observation of the characteristics of the people and their ways, he is enabled to come to a general conclusion as to the individuality of the place, and is thus in a position to draw comparisons with other populous centres with which he is acquainted.

Ordinary industry and habits of observation should in this way enable us to have an intelligent apprehension of the life around; but when we wish to look into the state of life and work in our own or other cities during past generations, the conditions are wholly different, as we must then depend upon descriptions left us by others, and view the past through other eyes than our own. We are therefore grateful to the traveller who has left any record of his experiences, and to the artist who has faithfully delineated by picture or plan the condition of the buildings or arrangement of the city in the past. This interest in the life of the human race, especially in reference to prehistoric periods, is widely extending. The excavations in Egypt, Asia Minor, and at Pompeii, which

have been carried out with scientific skill and painstaking industry, enable us now to gain very accurate ideas as to the conditions of life in far-past ages.

It is, therefore, the object of the present chapter to present in a general way to the reader some glimpses of the past of Glasgow, without attempting detailed descriptions or finished pictures, as that has already been well done in the many excellent works published by local authors.

Glasgow seems to have impressed the visitors who at various early times came to the city from the south, as we find from many of their recorded views. Of these enterprising travellers the most loquacious is Pennant, who took such a fancy to Scotland that he made as many as three different tours through the country, penetrating even to the most northern parts. Defoe and Johnson also found time to pay visits to the city on the Clyde.

Defoe, travelling in 1727, says: "Glasgow is the emporium of the west of Scotland, being for its commerce and riches the second in the northern part of Great Britain. It is a large, stately, and well-built city, standing on a plain in a manner four square, and the five principal streets are the fairest for breadth, and the finest built that I have ever seen in one city together."

Dr. Johnson while in Glasgow, after his return from his West Highland trip in 1773, said: "To describe a city so much frequented as Glasgow is unnecessary. The prosperity of its commerce appears in the greatness of many private houses, and a general appearance of wealth."

Pennant, however, enters completely into the life and work of the city, his remarkable power of observation, and his cultivated tastes, enabling him to write fully and attractively on the subjects which came before him. Speaking of the city, he says: "Glasgow, the best-built of any second-rate city I ever saw, the houses of stone and in general well built, and many in good taste, plain and unaffected." He then goes on to describe in detail the various places of interest.

One of the best books which we have for bringing up the past of old Glasgow in its social aspects is Dr. Strang's *Glasgow and its Clubs.* Here we have spread out before us a varied panorama of the life of these old days, or, as stated in the title-page, "*Glimpses of the condition, manners, characters, and oddities of the city, during the past and present century.*" From this work we see that club life was much in vogue in those days, as nearly thirty different social unions of this description are noted by the genial writer. Some of them had curious names, such as: "The Face Club," "The Sma' Waft Club," "The What-you-please Club," &c. At the time in which these clubs were in their glory, about 130 years ago, the population of the city was under twenty-five thousand, the streets were few, and the industries, now so multifarious, scarcely developed. The fashionable centres at that time were in the neighbourhood of the Cross, the famous Bailie Nicol Jarvie of Sir Walter Scott's *Rob Roy* having his domicile in the Saltmarket.

Apparently in these days Glasgow, like the older part of Chester, had many houses built over arcades. It is

not many years since we had the fine arcade at the Cross, in front of what was at one time the Exchange.[1] Arcades still exist in Glasgow, consisting of double rows of shops covered in with a glass roof, forming convenient shopping centres, especially in wet weather.

Club life appears to have been an important institution of the old times, the citizens meeting in the evenings to enjoy social recreation after their duties in the shops and warehouses, and where no doubt many subjects affecting the social welfare of the community and the progress of the nation would be discussed. Thus in speaking of the Post-office Club, which appears to have taken much interest in the venture of Henry Bell in starting the *Comet*, Dr. Strang says: "Considering the quality and character of the members of the Post-office Club, it is scarcely necessary to say that in the successful result of Henry Bell's practical experiment they felt the deepest sympathy—wisely accounting it better than all the speculative theories which had hitherto been promulgated;—and, as a token of that sympathy, it may be added, that to certain of the members of this mercantile fraternity belong the honour of having afterwards aided in the establishment of our first coasting, and thereafter of our ocean steamers."

The Hodge-Podge Club appears to have been made up largely of the Tobacco Lords, who were the aristocratic merchants of the time. This club appears to have combined literature with amusement and good cheer.

[1] The quaint sculptured faces which at that time formed part of the piazza, may now be seen grimly surveying the present-day life from their elevated perch on the top of a warehouse at the foot of Buchanan Street.

"A club of choice fellows, each fortnight employ
An evening in laughter, good humour, and joy;
Like the national council, they often debate,
And settle the army, the navy, and state.
In this club there's a jumble of nonsense and sense,
And the name of *Hodge-Podge* they have taken from thence."

One of the originators of "The Gaelic Club," was Mr. George McIntosh, whose son, Mr. Charles McIntosh, born in 1776, was the inventor of the process of waterproofing known by his name.

The citizens of those days dealt principally in the markets, one being at the Cross for butter and eggs, and another at Bell Street for butcher-meat. There was no water supply, the wells being the only source of that necessary. Towards the close of the eighteenth century the principal hotels were limited to four—The Black Bull, Buck's Head, Star, and Tontine. The Black Bull stood on the north side of Argyle Street, near Glassford Street, and the Buck's Head at the corner of Dunlop Street, the latter well-known building with its outside stairs having recently given way to the progress of the age.

The dinner hour appears to have been three o'clock, at which the wines were port and sherry, these being succeeded, Dr. Strang tells us, "by the largest china bowl in the house. In this gorgeous dish, which was of course placed before the landlord, the universal beverage of cold punch was quickly manufactured; and towards its proper concoction many opinions were freely offered; but to these the host, if a regular punch-maker, paid little attention. The ceremonial was always gone through with great deliberation, and with an air of

self-importance that must have made a stranger smile. The pleasing decoction once made and approved of, it was now the time to sit in for serious drinking—and serious indeed it often was, for while toast followed toast and bowl followed bowl, it rarely happened that the party broke up till some of the members at least were not in a condition to return to their homes without the aid of companions, who, if their heads were less *muzzied,* possessed more stable legs."

A graphic description of a Glasgow Lord Provost's dinner in the beginning of the present century is given in the pages of *Cyril Thornton,* in which he tells us that " the ladies were no sooner gone than Bell Geordy made his appearance, bearing a bowl of extraordinary dimensions, which he deposited on the table. Lemons, sugar, limes, rum from Jamaica and the Leeward Islands, soon followed, and expectation sat on every brow." The author then graphically describes the difficulty experienced in getting any of the guests to "handle the china," but finally this is accomplished, when, " every improvement which human ingenuity could devise with regard to the punch having been at length suggested, the business of drinking commenced in good earnest, each replenishing of the glasses being prefaced by a loyal or patriotic toast by the Lord Provost. 'The King,' 'The Queen,' 'The Prince of Wales,' 'The Trade of Clyde,' having been drunk in bumpers, the current of conversation was gradually diverted into other channels."

The " tea parties" were held at an early hour of the evening, the guests getting home in good time.

The gentlemen of those days walked abroad in blue

coats and buff-striped waistcoats, with great shirt frills, and white neckcloths, also, knee-breeches with shoes. The dress of the ladies appears to have been plain, and favouring black silks and laces.

As yet there was no police force as we understand it. Pennant, in his tour in Scotland in 1772, speaks of the guard-house "where the inhabitants mount guard and regularly do duty;" and he further adds, "The police of Glasgow consists of three bodies—the Magistrates with the Town Council, the Merchants' House, and the Trades' House." It appears that the citizens made arrangements at a later date to avoid this somewhat compulsory duty of watching, and employed representatives.

The earlier watchers of the city appear to have been the town-officers, wearing red coats, these being supplemented at night by watchmen, who were principally old men, and who made themselves as comfortable as they could in wooden sentry-boxes placed at different parts of the town. One of these retreats was a niche in the wall at the foot of Balmanno Street, now built up. These old guardians often retired about eleven o'clock to their boxes, drew on their night-caps, and had a quiet snooze, liable, however, to have the door locked on them by some passing wag, or, what was worse, the box turned over altogether.

One of the town's officers was noted for his characteristic appearance and humorous remarks, acting as he did as bellman and town-crier. He was usually known as "Bell Geordy." His real name appears as George Gibson in the pages of the first Glasgow Directory, in a list

of town's officers and sergeants, numbering eighteen in all, his habitation being Lochhead's Close, High Street. Being a big stout man, dressed in a scarlet coat, and with a turn for humour, he was quite a noted character; and in his combined functions of bellman or town-crier, town-officer, and provost's man, was an important individual, and is still remembered by septuagenarian citizens.

Cyril Thornton, when dining with a Lord Provost of the year 1802, describes in graphic terms his announcement to his lordship's drawing-room by this worthy, who tries to keep his assistant "Hector" (another town-officer) right by saying: "I carena whare he's frae, but I want his name. Didna I tell baith you and Duncan to cry oot a' the names to me, that they may be properly annoonced?"

When a fire occurred Geordy turned out with his drum, a crowd of boys following him, eagerly asking "Whaur's the fire?" but getting often put on a wrong scent by the astute and humorous herald.

The dress of these ancient members of "the force" seems to have been of a nondescript character. Later on the police garb appears to have been a dress blue coat with a red collar; afterwards the buttoned-up surtout of the present time. Sticks and tall hats were formerly worn, instead of the helmet and baton of to-day. The police force of Glasgow at the present time is about 1100 strong. The night policeman, until a few years ago, was in the habit of calling out the hours and the state of the weather, so that besides his more immediate protective duties he combined the office of time-piece and meteorological register, and thus, accompanying

his heavy footfall echoing in the silent streets, the gradually-awakening citizens heard the watcher's voice crying:—"Hauf-past five and a fine mornin'."

This practice of intimating the condition of the weather by night watchmen to those indoors seems to have held good in other towns of this and other countries. In some towns of Sweden and Norway, where, owing to the numerous wooden houses, fires are more common than in stone-built cities, the watchmen used to call out something to this effect:

> "May God still keep the town from fire
> While the citizens sleep."

The following, which is called the "Watchman's Song," is of German origin:

> "Listen, townsmen, hear me tell
> Ten hath struck upon our bell;
> God hath given commandments ten,
> That we might be happy men.
> Nought avails that men should ward us,
> God will watch and God will guard us.
> May He of his boundless might
> Give unto us all good night."

The song goes on with a verse for each hour until after four o'clock, when he sings:

> "Now all stars must fade away,
> Quickly now must come the day.
> Thank your God, who through each hour
> Kept you with a Father's power."

In Kennedy's volume of *Singing Round the World* we find this practice referred to as existing at the present time in St. John's, Newfoundland, as also the

more modern one of the "time-gun." Thus the writer says: "An eighteen-pounder fires every day at noon; while at eleven o'clock P.M. a watchman patrols the street calling out the hour, adding 'and a clear starlight night,' or whatever the sky might be."

In old Glasgow the lamplighter made his rounds with his flaring torch, whale-oil lamp, and ladder on shoulder, ready to mount to the street lamps, which then projected from the house walls. Carrying all these impedimenta he had no spare breath for vocal announcements like his contemporary the watchman; but what he failed to supply was volunteered by the boys of the city, who greeted him with their

> "Leery, leery, licht the lamps,
> Long legs and crooked shanks."

The lamplighter of modern Glasgow is independent of ladder and almost of hand-lamp, as, rapidly passing along the streets carrying his pole with its small lamp at one end, he deftly turns the stop-cock and pokes his pole through the hole cut in the bottom of the glass globe, thus lighting the gas more quickly than can be described.

Giving us a picture of the modern city, Mr. Wm. Black, in *White Heather*, tells us: "This golden—radiant city of Glasgow!—with its thousand thousand activities all awaking to join the noise and din of the joyous morning. The interminable thoroughfares, the sky-piercing chimneys, the masses of warehouses, the overhead network of telegraph lines, the red-funnelled steamers moving slowly away through the pale blue mist of the Broomielaw."

Perhaps nothing shows better the extent and resources of a great commercial city than the means now adopted for the checking of the spread of fire. Not only does this appear in the high pressure of our modern water supply, by means of which a hose fixed on a fire hydrant will convey a stream of water to our high buildings, but also in the steam fire-engine, with its powerful pumps and capacity for rapid steam raising, all enabling the fire brigade to effectually cope with the most serious outbreak.

Without a proper supply of water, and machinery to utilize it, any outbreak of fire could only be dealt with in a very primitive fashion. Indeed, to a comparatively recent period the "butts" were a great institution, for when a fire broke out a dash was made with these water-barrel carts, the first carter getting a sum of money as a premium to hasten up the supply for the small engine worked by hand. The West of England Company placed a more modern type of fire-engine in the city about forty years ago, which with its helmeted firemen was the great attraction of the youngsters as it urged its course to the scene of the conflagration.

About forty years ago the announcement of an outbreak of fire was made by means of a drum by day and a rattle by night, the latter, consisting of a set of big "clappers" made of loose pieces of wood, tied in such a manner as to cause a strong rattling noise when shaken by the hand, the night policeman at the same time crying out fire at such and such a number and street. The clappers were only disused a few years ago, as the spread of the city and the modern improvements

in the communication of messages by means of electric signalling combined to render the slow transmission of the news by word of mouth of no effective service.

The celerity with which the fire-brigade can be turned out varies somewhat, depending a good deal on the necessities of the case. In our own city, where with our solid stone buildings and stone stairways, more resistance is offered to the spread of the devouring element than in lighter-built brick houses with wooden stairs, or in wooden houses throughout—as is the case in many towns in America—there is not such danger of the fire obtaining the mastery. Still, in the interests of the community, the quicker a fire is put out the better.

The fire-brigade of Glasgow do not pretend to the speed of the Chicago firemen, who can turn out in a few *seconds*, being stimulated, if asleep, by the electric current "hitching" the bed-clothes off them and almost dropping the active brigaders through the opening trap-door of their room on to the fire-engine standing ready in the ground-floor below. The average time taken in Glasgow to turn out is about a minute and a half.

Besides the fire-engine to send the current of water on the burning mass, we have the fire-escape, a familiar object, especially in London, as a long strange ladder-looking apparatus standing in some quiet corner of the busy city, ready to be brought out and run to the nearest fire. In America, however, the traveller moves and sleeps in an atmosphere of contingent fire; in the hotels he sees placards "To the Fire Escape," and directions to the nearest exit. Recently an invention was patented for enabling an individual to escape single-handed by means

of a reel of steel wire, one end of which he screwed into the window-sill. Securing himself to the reel, he then, with a faith in a successful journey which could only be implanted by the urgency of the occasion, is supposed to launch himself out into space and descend spider-like by means of his reel and wire.

Besides the use of water to extinguish fire, chemists have supplied us with compounds in cases, which, by the quality of the gases emitted, smother the flame.

In Mr. Nicol's excellent *Statistical Account of Glasgow*, published in 1885, the following reference to the early methods of coping with the city fires appears:— "The first fire-engine was got by the corporation in 1657, five years after the great fire which destroyed one-third of the town from the Trongate southwards, and unhoused some thousands of people. The engine was similar to one in use in the Capital, and its functions are described in the Council minutes as for 'the occasioune of Suddent fyre in spouting out of water thereon.' As another destructive fire, from the Trongate northwards, occurred in 1677, the engine, if brought into use, would appear to have been inadequate. And no wonder, seeing great part of the structure of Glasgow houses was then of wood."

Later on fires became less disastrous as the use of stone became more general; although we find that in some towns the use of wood was so much preferred that after the great fire in Dunfermline in 1624, in which 220 houses were destroyed, the wood of Garvock, in the neighbourhood, was completely denuded of its old trees for the rebuilding of the town.

The strength of the Glasgow fire-brigade, according to the published report for 1886, is as follows:—Permanent firemen, 81; auxiliary firemen, 54; horses, 17; 6 steam fire-engines; 9 manual fire-engines; 19 hose and ladder carriages; about 7500 yards of hose on engines and carriages, with over 3000 feet of spare hose; about 600 feet of scaling-ladders; 1 telescopic fire-escape; and 83 electric street fire-alarms. During 1886 there were 244 fires at which the engines were called out, and 128 at which the engines were not called. Of fires which occurred, 154 happened through the day and 218 during the night. Of these fires 326 were extinguished by firemen, and 46 by occupants and others. The bulk of the calls were through the electric fire-alarms, a good many being of a malicious character, ending in nothing but a turn-out of the brigade.

The average annual loss of property in the city by fire during the last six years is valued at about £134,000. Physicists tell us matter is never lost, and, like energy, it simply changes its form. In the case of a large city fire we have a striking spectacle of such transformation, the stored-up valuables, whether of art or commerce igniting and disappearing in flames, sparks, and smoke, whilst the inclosure becomes a roaring furnace, and the walls themselves crack and splinter under the fervent heat. Meanwhile the vital energy on the streets below, in the shape of the daring firemen, scorched by the heat and blinded by the smoke but undaunted in their efforts, directs the play of the water-hose to arrest the destruction going on; for whatever the result may be physically, it is a loss commercially, as much as when a gallant ship

founders and takes her cargo down to the depths of ocean. Strange it is in this advanced age of applied science that, as yet, we have to lament those appalling catastrophes of fire, in which not only valuable property but infinitely more valuable human lives are destroyed in a short hour or two.

Previous to the year 1750 there were no banks in Glasgow. In that year, however, several of the merchants started what was known as the Ship Bank, the notes issued bearing a ship engraved upon them. In the first Glasgow Directory, published one hundred years ago, we find seven banks mentioned, viz.: The Glasgow Arms Bank, Ship Bank, Thistle Bank, Merchant Bank, Royal Bank, Messrs. Thomson's Bank, and Paisley Bank.

The following lines, which quaintly and graphically portray the changes which have come over our old city during the space of the last century, appeared in the *Glasgow Herald*, and were written for the centenary of that newspaper, February, 1882:

"A hundred years ago! As in a dream
All things have changed along the human stream,
The thousand roaring wheels of traffic pass
Where the maids spread the linen on the grass;
The mighty ocean liners outward bound
Heave o'er the spot where windmill sails went round.
The haystacks of the Trongate, where are they?
Where the green meadows which produced the hay?
Who were the last fond lovers (who can tell?)
That kissed beneath the alders at Arn's Well?
Oh, quaint Arcadian city which appears
In the bright vista of a hundred years!
The ancient merchant in his scarlet cloak,
Great wig and silver buckles, if he woke

From his archaic slumber, would he know
Th' Havannah of a century ago?
In that brave year of seventeen eighty-two
The stars looked out of smokeless heavens and knew
The city by its nine dim lamps. At dawn
The glimmering vapours from the Bens were drawn."

These are a few of the brighter aspects of the "good old times;" but there are other aspects less pleasing. Fortunately the latter are not necessarily specially identified with Glasgow, but belong to an age now fortunately passed away, when regard to the value of life and living had not taken the high position of the present day.

The execution of criminals for what we would now call comparatively trivial offences was the law of the land. The condition of the unhappy prisoners incarcerated within the jails for crime or debt was miserable in the extreme. Jail-fever was a disease by itself. The "Hulks" still existed for convicts, at places such as the Thames, Plymouth, and Portsmouth; from which detachments were sent from time to time to Botany Bay.

Howard, in his work on *Prisons*, &c., says: "On my coming into Scotland in July 1787 the first *county gaol* I visited was at Ayr. There is no court, so that debtors and felons are never out of their rooms.

"There is the same defect in the *Tolbooth* at Glasgow. As the transports continue long in confinement, some alteration was making, by arching the rooms, in order to obtain greater security against escapes and disturbances.

"Several of the transports were removed to a *new prison* adjoining to the poor-house. Each had a separate room (about six feet and a half by six). The rooms here

not being very strong, the prisoners had *chains* on their *feet* and *necks*.

"The passage being only two feet eight inches wide, most of the rooms were very offensive, and some very damp. No endeavours are made to *reclaim* these unhappy objects; whose long *confinement*, together with the great severity of their chains, and their scanty food (being only two pennyworth of bread in a day), must reduce them to the extremity of misery and desperation."

Mr. Howard adds: "The *Tolbooth* is in the Tower, has no apartments for the keeper, no court, no water, no sewers, and seems as if it was never whitewashed; allowance to prisoners 4*d*. a day; 1787, Augt. 3, prisoners 4."

One bright gleam falls across this dismal picture. We are told that the magistrates expressed "their readiness to make any alteration for the benefit of their fellow-creatures." The magistrates also accompanied Mr. Howard on his visits, and presented him with the freedom of the city.

Since in dealing with such far-back matters we can only gain our information from records of the times, it may not be out of place to refer to a later description[1] of the new jail of Glasgow built in 1810, where we are told that "In its construction much attention has been paid to the health and comfort of the unfortunate; and while it is to be lamented that the crimes of men render such a structure necessary, it is at the same time agreeable to reflect that, in promoting security, humanity has not been overlooked.

"The superintendence of building the jail was in-

[1] *Picture of Glasgow*, Chapman, 1820.

trusted to Mr. James Clelland, whose zealous exertions on the public account have been eminently conspicuous on many occasions. From his judicious suggestions, the cells for the reception of criminals under sentence of death were constructed. In these, the wretch who had hitherto pined in irons, and under a restricted use of his limbs, may now, even in his dreary cell, employ them with freedom in acts of exercise and devotion."

That this humane spirit was now growing in the community we can readily gather from part of the inscription on the plate over the cavity in the foundation-stone.[1]

"To afford more suitable accommodation
Such as the increasing population
And wealth of the City
Have, for many years, required for those
Engaged in the Administration of Justice, and in
The Management of the Affairs
Of the Community:
And to provide
More convenient Places of Confinement,
Secure, and yet not injurious to Health, for
The unfortunate Individuals
Whose Imprisonment
Their Debts, or their Crimes
May render legally necessary,
The Magistrates and Council of Glasgow
Have resolved, after mature Deliberation,
To erect these Buildings
By the favour of Almighty God."

The first ten or twelve years of the beginning of the present century appear to have wrought a great change in the size and appearance of the city and of the manners

[1] See *Glasgow Municipal Buildings:* by John Carrick and James Nicol, 1883.

of the people. Thus the population of the city has been stated in 1795 at about 70,000, whilst in 1819 it was 147,000. This great change is graphically portrayed in the pages of *Cyril Thornton,* where this gentleman says: "Though in the external aspect of Glasgow little change was apparent from the lapse of years which had intervened since my former visit, yet a great change was certainly observable in the manners and mode of life of its inhabitants. Wealth had evidently increased, and exotic luxuries and fashions had taken root in the soil. At the epoch of my former visit the city boasted but one carriage; now gay equipages, with servants in gaudy liveries, were to be met with in every street. Formerly a few clumsy and Quaker-like buggies, drawn by horses better fitted for the plough than the shafts, might be seen lumbering along, conveying a physician on his rounds, or an elderly gentleman and his wife to their cottage in the suburbs; now vehicles of the smartest and most fashionable description, whether designated in the nomenclature of the day as Dennet, Stanhope, Whiskey, Tilbury, or Drosky, glittered past with almost meteor-like velocity in all the great avenues of the city. The ideas of the generation which had been springing up during my absence evidently differed widely from those of their fathers. . . . Several new and elegant streets had sprung up to the westward of the city, and the gayer and more wealthy part of the population had deserted their former small and smoky residences, for the more elegant and commodious mansions which these afforded."

In reference to early commercial matters in Glasgow Dr. Strang says: "While the tobacco trade existed, as we

have already seen, the class engaged in this lucrative business was limited, and their position in society was special and prominent. But no sooner had the Virginia lords thrown aside their scarlet cloaks, gold-headed canes, cocked hats, and bushy wigs, and left the field open to the ambition and enterprise of the wider circle of merchants engaged in the growing commercial intercourse with the West Indian colonies and foreign countries, than a new order of things began to be developed. Business of all kinds became diffused among the citizens. The two great classes of society, into which the city has been so long divided, gradually disappeared. The merchant and manufacturer were now seen amalgamating; while the strict social barrier, which so long separated the tradesman from the foreign trader, was henceforth swept away amid the daily intercourse of business men, which, after 1781, had been taking place under the canopy of the public News-room at the Cross. Trade, in fact, was now regarded under a new and more universal phase; and society assumed a more cosmopolitan condition, under a happy amalgamation of all classes."

CONVEYANCES.

Living as we do in prosaic railway times we can only form pictures of the past coaching days, yet, from a well-appointed tourist coach in the Highlands or elsewhere we may gather some idea of what the Royal Mail Coach with its four spanking horses, driver, and guard must have been, and the excitement which their arrival and departure caused at the towns on the way and at the terminus of the run. Professor Rankine, with happy

facility, has thus sung in praise of the older method of transit:

> "Ye passengers so bothered
>   Who snore in rattling trains,
> By dusty vapour smothered,
>   Awake and hear my strains!
> I'll tell you of the good old days,
>   For ever past and gone,
> Before your pestilent railways
>   Had spoiled all sorts of fun.
> When Joe, with light but steady hand,
>   Did four high mettled steeds command,
> And well was known, through all the land,
>   The coachman of the 'Skylark.'"

One hundred years ago the mail-coach was called a diligence; and we are told in the first *Glasgow Directory* that "it sets off from James Buchanan's Saracen's Head Inn upon Sundays, Tuesdays, and Thursdays at 12 o'clock at night,—arrives up on Saturdays, Mondays, and Wednesdays at 9 o'clock at night." Dr. S. Smiles (*Lives of Engineers*) tells us:

"With the progress of industry and trade, the easy and rapid transit of persons and goods had come to be regarded as an increasing object of public interest. Fast coaches now run regularly between all the principal towns of England, every effort being made, by straightening and shortening the roads, cutting down hills, and carrying embankments across valleys, and viaducts over rivers, to render travelling by the main routes as easy and expeditious as possible. Attention was especially turned to the improvement of the longer routes, and to perfecting the connection of London with the chief

towns of Scotland and Ireland. Telford was early called upon to advise as to the repairs of the road between Carlisle and Glasgow, which had been allowed to fall into a wretched state. . . .

"Although Glasgow had become a place of considerable wealth and importance, the road to it north of Carlisle continued in a very unsatisfactory state. It was only in July, 1788, that the first mail-coach from London had driven into Glasgow by that route, when it was welcomed by a procession of the citizens on horseback."

Mr. Smiles further mentions that the road had become so dangerous that the mail was often delayed, and that the bridge over the Evan water fell with the coach, several persons being killed and others injured. At length, in 1816, a Parliamentary grant of £50,000 was made, and the new road carried out by Telford, who executed the work in a substantial manner, with easy gradients, about one in thirty being the steepest inclination.

The railway system has swept away the old mail-coach; but it is curious to note how the tendency to carry on old associations exists amongst us, as in the early railway carriages much similarity existed to the older forms, the "guards" sat outside on the top of the carriages, and some of the carriages were open above; the run to Greenock in the open and stand-up vehicles being quite within the memory of many. In the first edition of *Chambers's Information for the People*, published about 1848, we read: "Carriages are usually divided into three classes, first, second, and third. The first are covered, and resemble three coach bodies united. Each compartment is double-seated, the seats being sepa-

rated by cushioned arms or supporters, thus preventing the passengers crowding one another. The whole interior is lined, cushioned, carpeted, and lighted; presents as much elegance, and affords as much luxurious ease, as any nobleman's carriage. The second class carriages—originally very uncomfortable concerns—are now covered and provided with windows, and on some lines are furnished, like the first class, with lamps, and soft cushions for seats. These are not divided into compartments, but are calculated to hold, without crowding, from four to six passengers on each side. The third class carriages were originally quite open, and in some cases entirely unprovided with seats; but now the parliamentary third class—so called from companies being obliged to run them by act of parliament—are very comfortable conveyances, infinitely superior to the outside seat of a mail or stage coach. They are covered and furnished with seats and windows."

In connection with the opening up of the country by railways the following extract from an interesting work on the *Rise and Progress of the Midland Railway,* by Mr. F. S. Williams, is of much interest: "But at length the monopoly even of canals began to be threatened. A new competitor was coming into the field. The Stockton and Darlington Railway had been completed, the Liverpool and Manchester line was in course of construction, and the idea was spreading that railways were likely to succeed. Two or three enterprising men in Leicester shared these impressions, and they conferred on the subject with Mr. John Ellis, their townsman. He replied that he had no practical acquain-

tance with the making or working of railways; but he did not discourage the project. At that time he was associated with some other gentlemen in the reclamation of a part of Chat Moss,—that vast morass over which George Stephenson was then carrying the Liverpool and Manchester Railway; and Mr. Ellis promised that he would ask the advice of his friend Stephenson. Accordingly, a week or two afterwards, Mr. Ellis went from Chat Moss in search of the great engineer, and found him very busy, and, we must add, very 'cross,' in Rainhill Cutting. 'Old George,' as he was familiarly called, refused to discuss the matter. Mr. Ellis for a while forbore with his friend's infirmity, and at length induced him to go to a village inn hard by, that they might have a beefsteak together for dinner. Here good humour soon returned; Mr. Ellis explained his plans, and George Stephenson undertook to go over to Leicester and see the country. He did so; and his report as to the practicability of a railway being carried through it was favourable. He was then requested to undertake the office of engineer. This he declined. 'He had,' he said, 'thirty-one miles of railway to make, and that was enough for any man at a time.' But, being asked if he could recommend any one for this service, he mentioned the name of his son Robert, who had recently returned from South America, and the father added that he would himself be responsible that the work should be well done. The matter was so arranged; and when, not long afterwards, a difficulty arose in obtaining the requisite capital for the new undertaking,—in consequence of many of the well-to-do Leicester people being already interested

in canals,—George Stephenson further showed his practical interest in the work. 'Give me a sheet of paper,' he said to his friend Ellis, 'and I will raise the money for you in Liverpool.' In a short time a complete list of subscribers was returned.

"The Leicester and Swannington line was commenced about the latter end of the year 1830; and one spring morning in 1832 Mr. Ellis said to his son, then a lad of fifteen, 'Edward, thou shalt go down with me, and see the new engine get up its steam.' The machinery had been conveyed by water from Stephenson's factory at Newcastle-on-Tyne to the West Bridge Wharf at Leicester; it had been put together in a little shed built for its accommodation; it was named '*The Comet;*' and it was the first locomotive that ever ran south of Manchester.

"On the 17th July, 1832, amid great rejoicings, and the roar of cannon that had been cast for the occasion, the new line was opened—a line which brought the long-neglected coal-fields of Leicestershire almost to the door of the growing population and thriving industries of the country town."

In this same volume is a racy bit of experience by an engine-driver, which shows that the iron horse has his peculiarities like his four-footed namesake. "A good engineman takes a pride like in his engine, as if, you know, she was his own property, and we know what we can coax out of her; and, what's more, what we can't. We have to fire the engine on the lightest part of the road, that is, when she's running down banks and such like, and has the least blast on. If we put coal on when the blast is strong, up the chimney the small coal

goes, into the smoke-box, and flies up out of the chimney. It is the fireman, you know, that watches the fire and keeps the steam up by the indicator as the driver requires him; and both driver and fireman have also to keep a sharp look-out ahead."

The canals, doubtless, suffered by the introduction of the railways, but, strangely enough, we are now coming round to favour once more the inland water-ways; and the gigantic undertaking of the Manchester Canal now commenced, which will cost several millions, and is designed to admit sea-going vessels into the heart of the country, will be one of the greatest engineering works in the country, at least of the present time.

If the changes during a dozen years of the early part of this century were so marked, how shall we record those which have taken place during the seventy years which have elapsed? The one hundred and forty odd thousand persons have grown to some 700,000. The boundaries of the city have extended not only westward, but on all sides, until now it is difficult to define them, and the spaces between the city and neighbouring towns some miles off are getting, by mutual extensions, less and less year by year. The steamboat and the railway train have now far exceeded in power and speed the old flies and diligences, and even the "meteor-like velocity" of the improved vehicles referred to. Hansom cabs and tram-cars, horse and steam, have superseded the clumsy "noddies" and sedan-chairs; and all these supplemented by telegraph and telephone communication. In addition we have water brought from a Highland loch, and gas for lighting and heating distributed

through this industrial hive in a net-work of underground pipes.

The use of steam-power on ordinary roads was early attempted in Glasgow. One road-locomotive, spoken of as Gurney's engine by old residenters, made some eccentric movements on the south side of the river, and exploded once or twice. These engines met with great opposition, the roads being heavily metalled to prevent their progress, which led in one case to the breaking of an axle in England, and to the final destruction of the Glasgow carriage between Paisley and Glasgow, where, pressing the steam too high to get through the heavily-metalled roadway, the boiler blew up, injuring the passengers. Gurney was a Cornishman, and, like his countryman, Trevethick, seems to have been a born engineer.

Scott Russell's name is also associated with the Glasgow engine or coach; and it is said that Symington, the designer of the *Charlotte Dundas* steamboat, tried one in Edinburgh. In the *Scots Mechanic's Magazine* for 1825 there is a drawing and description given of a proposed steam-carriage, spoken of as follows: "This improvement in the construction of steam-carriages consists in adapting separate engines to the gear of each of the wheels on which the carriage runs, instead of actuating them all by one engine." It is doubtful if this very direct application of the power would be successful, as the traction-engines and road-steamers of the present day owe part of their success to the geared connection of the engine and the wheels. We also hear of a steam-coach in the *Noctes Ambrosianæ* in 1827, where the Shepherd is speaking of the dry summer of 1826, and

of the roads in the south towards Berwick, when North says, "The steam-engine mail-coach is to run that road in spring;" and the Shepherd adds, "Is't? She'll be a dangerous vehicle—but I'll tak' my place in the safety-valve."

POSTAL SERVICES.

The amount of work got through by a post-office should be a good indication of the business character of the town or city in which it is established, and the Glasgow post-office is an excellent illustration of the rapid progress of the city from time to time; and as showing the extent of the resources of this establishment we find a volume published by the post-office officials in 1887 and called *The Queen's Head*, from which we can gather at a glance a great deal of valuable information about the rise and progress of postal work in Glasgow.

It appears that in 1695 the Scottish Parliament established a letter post, and for a time the letters were wholly conveyed on foot. In the year 1711 one post-office system for both England and Scotland was established. The first direct London and Glasgow mail was established by coach in 1788. Apparently the first Glasgow post-office was started in the year 1787, over one hundred years ago. It was situated in Princes Street, and looking at a copy of the first Glasgow Directory we find that the staff consisted of five persons, viz.: a postmaster, a head-clerk, an under-clerk, a letter-carrier, and another whose functions are not stated. After some changes of place, in 1810 the post-office was situated in Nelson Street, and citizens still living can recall their

delight as boys when seeing the mail-coach arrive in the Trongate, and the important guard get off his perch, pull out his mail-bags, and walk up Nelson Street to the office, the pistols or blunderbusses which were his companions on the road being beheld with proper respect by the onlookers.

In 1840 a removal was made to Glassford Street, where many can remember the piazza or arcade front to the street. This was a marked period in postal history, as in this year the uniform penny postage came into operation and postage stamps were first used.[1] In 1857 the post-office found its present home in George Square.

The following interesting tabular statement of the staff is given in *The Queen's Head*:—

In 1787...... 5.	1869...... 268.
1826...... 22.	1870...... 449.
1840...... 58.	1872...... 455.
1848...... 98.	1887......1402.
1857......150.	

The number of letters now dealt with is about 2,500,000 weekly. The revenue is £336,000, and expenditure £107,000. Besides ordinary letter work, post-offices have not only to deal with money-orders, &c., but with all kinds of parcels since the introduction of the parcel-post system, and with telegraph messages.

BUILDINGS.

The Cathedral was founded in 1123, during the reign of David I., and was dedicated to St. Mungo. It is situ-

[1] The postal rates formerly varied within the United Kingdom, and it is said that a boy, who acted as postman in a country district, on being reprimanded for delay on the road, replied, "Oh, these are only penny letters."

ated on the higher part of the city at the head of High Street, and just above the banks of the Molendinar stream, where its patron saint established his humble cell thirteen centuries ago. The Cathedral, fortunately surviving the destruction of similar buildings about the time of the Reformation, is still an object of interest to visitors and of pride to the inhabitants for its pure and early English style of architecture, its crypt almost unique in its completeness and extent, and, although a modern decoration, its stained-glass windows are of such high-class work and artistic design as to be quite in harmony with the venerable structure, whose gray and sombre colouring by the hand of Time they serve to brighten with their rich and many-coloured lights.

Sir Walter Scott gives us in *Rob Roy* a picture of the Cathedral and its surroundings as they appeared when "The Mac Gregor" paid his occasional visits to Glasgow:

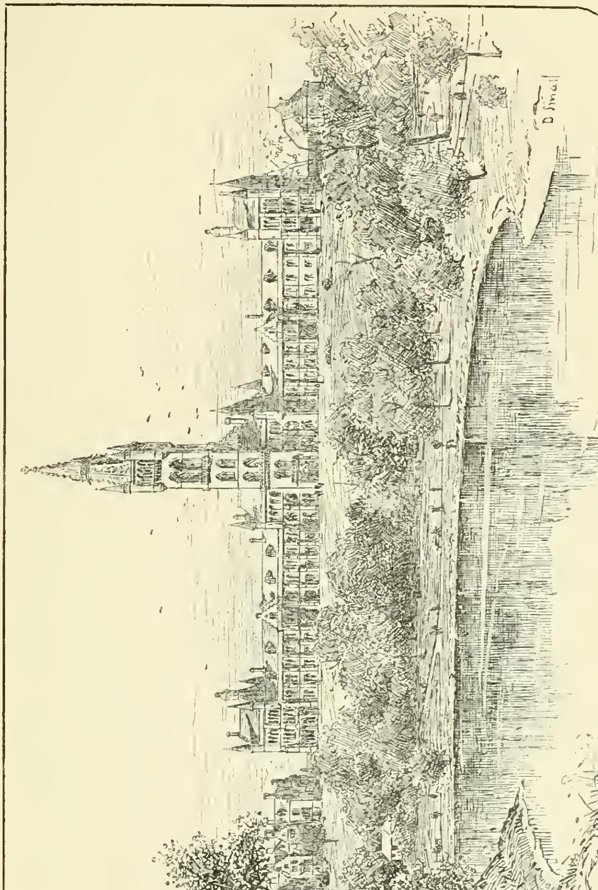
"Standing in a populous and considerable town, this ancient and massive pile has the appearance of the most sequestered solitude. High walls divide it from the buildings of the city on one side; on the other it is bounded by a ravine, at the bottom of which, and invisible to the eye, murmurs a wandering rivulet, adding by its gentle noise to the imposing solemnity of the scene."

At one time the building was divided as follows:—

The Choir, Outer Church, Inner High Church, and Vaulted Cemetery. Worship was conducted on Sundays in the Outer Church and the Inner High Church, and for a time in what was called the Vaulted Cemetery or Crypt; and it is to this lower sanctuary that we are conducted in the novel referred to, which is described

as "an extensive range of low-browed, dark, and twilight vaults," in which a numerous congregation had assembled, and where the hero of the story hears the whisper, "You are in danger in this place; meet me to-night on the Brigg at twelve preceesely;" and giving heed to this warning he meets Rob Roy, as "the hour of twelve o'clock swung its summons over the city from the belfry of the Metropolitan Church of St. Mungo, and was answered and vouched by all the others like dutiful diocesans."

The College buildings stood in High Street, but like many other things they also have had to give way to the changes which constantly occur in an ever-growing and widening industrial community. Where once the learned professor and aspiring student met in yearly session and devoted themselves to the advancement of learning and the cultivation of the mind, there is now little remaining to mark the site of their former abodes and class-rooms. The railway passes through them, and the snort of the iron-horse and his warning whistle echo through the colonnades of the railway-station which has taken their place. But is it not a fitting successor to the old halls and class-rooms where James Watt first made his immortal discovery, which gave the old and inefficient steam-engine a renewed vitality? As we stand on the platform, we see the locomotive with its train behind, the fire burning brightly and the steam up to its required pressure, with the electric light brilliantly showing from the carriage roofs, switched off and on automatically as the train dives out and in the tunnels driven beneath the busy streets. We feel that this is the outcome of much that



University Buildings, Gilmourhill.

has been lectured and experimented upon in the class-room and laboratory of the old buildings. And the names of Black, Watt, Rankine, and Thomson occur to us as workers in the field of science, whose investigations in this very place have helped to bring about these wonderful changes.

The University has now moved west; all modern life seems to tend westward, and since the time of Columbus we have pushed still further out into the new fields opening to the enterprising on the other side of the Atlantic. The new site is much more prominent than the original one in the High Street, yet no doubt in the early days the old buildings would be quite as well marked out, as the city was smaller and distances were not then reckoned by miles. Various recent endowments by wealthy citizens and others have contributed to the completion of the present buildings on Gilmourhill, and to the carrying on more completely the work of the various chairs. And not only have these benefactions resulted in the erection of the handsome modern structure, but also in the re-erecting of the old gateway, with the veritable stones cut by and bearing the chisel marks of the old builders a couple of centuries ago, and which once more throws its shadow over the student and visitor as they pass and repass to class-room and court, as in the days of old. We can also still pass up and down the old stone stairway with its guardian lion and unicorn, which was originally erected in the old college so far back as 1690.

George's Square, at one time a dismal, railed-in place, is now opened out to the public, and contains a number of monuments to distinguished names, combining royalty,

war, science, literature, &c. Sir Walter Scott from his lofty pedestal looks abroad over the city, whose old-fashioned life and incidents he has so well portrayed. Sir John Moore, whose death at Corunna is so dramatically described in the well-known lines:

> "We buried him darkly;—at dead of night,
> The sods with our bayonets turning;
> By the struggling moon-beams' misty light,
> And the lantern dimly burning."

Sir Colin Campbell, posed alert, and intense with readiness for action. Graham, the master of the mint, and Watt in scientific contemplation, Campbell and Burns, Livingstone and Peel, are all here; the unchanging bronze perpetuating by the magic skill of the sculptor the personal characteristics of each, while the busy city life goes on, and we hear arising from the constant murmur of the streets something like this:

> "For men may come and men may go,
> But I go on for ever."

Other statues adorn the city, such as that of the Duke of Wellington in front of the Exchange, where, mounted on his faithful charger, the "hero of a hundred fights" appears to be directing the movement of his troops on the battle-fields, depicted on the panels below.

Another and an older equestrian statue stands at the Cross, viz.: that of King William III., and of which the late Rev. Norman Macleod tells the following story:—

"The traveller who visits Glasgow and takes the trouble of walking along the Trongate, which would be a fine street in any city, will notice near the 'Cross,' at

its eastern extremity, an equestrian statue of no mean value as a work of art, and he will also discern two old guns protruding their small rusty muzzles above the ground at its base. Those guns blazed at the battle of the Boyne, and they now look up to King William III., who commanded them there. Strange to say, this is the only statue in Scotland or England erected to him of 'immortal memory.' A Latin inscription on the base of the statue inform us, among other things, that it was erected in 1734 by '*Jacobus Macrae*, Gubernator Madrasii.' We may add that this work of art was the only one of the kind known for more than a century to the peasantry of the West Highlands. The first object on reaching Glasgow which the Highlander went to see was the 'black horse;' and the first question asked of him when he returned home, by those who wished to hear his news, was, 'Have you seen the black horse?'"

A number of fine old mansion-houses built by the mercantile aristocracy of the last century at one time adorned the city, but are now mostly pulled down or incorporated with new buildings. One of these is interesting from the fact that it is built into the front part of the Exchange in Queen Street. This mansion-house was known as the Lainshaw Mansion; afterwards The Royal Bank used the upper or drawing-room floor for its business, and finally, when the Royal Exchange was built in 1829, the old building was preserved, and the new building, with its fine row of Corinthian columns, spread out over the old garden ground behind.

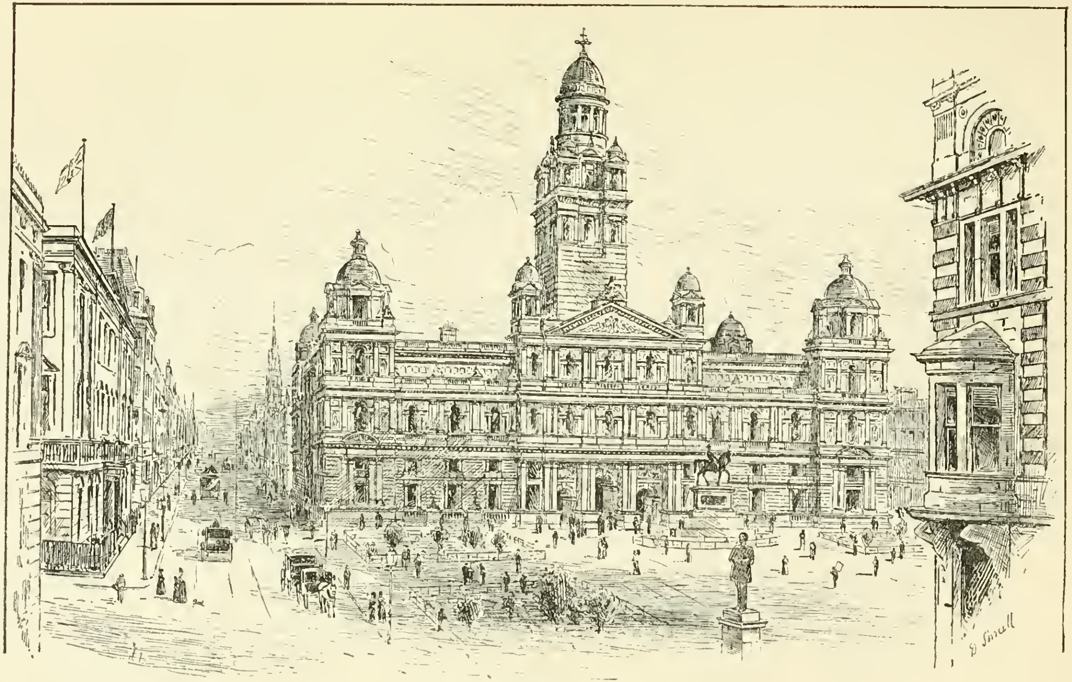
The new Municipal Buildings in George Square, approaching completion, constitute an elaborate and massive

The Trongate—Tron Steeple and Cross.

pile, in which the work of the various trusts connected with the municipality can be carried out, and the magisterial functions of the representatives of the city can have freer scope in the Council Chamber. The foundation-stone was laid on 6th October, 1883, with all the masonic honours, and Glasgow kept high holiday in honour of the event, the various trades turning out in their thousands, as the Glasgow tradesmen love to do on any great occasion, and carrying on for the edification of their fellow-citizens their various crafts; working away on stages carried by lorries, drawn by gaily-caparisoned horses. This great procession, reckoned at about 30,000 strong, headed by the carters mounted on their splendid Clydesdales, specially decorated for the occasion, made a tour of the city, and finally converged on the square.

The building is in the Italian Renaissance style, and occupies a square of about 75 yards on the side, thus covering an area of about 5600 square yards. There are several stories, the main walls reaching to a height of 75 feet, having a central tower rising to a height of 242 feet, of which 225 feet is of masonry, terminated with 17 feet of ornamental gilded metal work. Besides the Council Chamber and various offices a large banqueting hall is one of the features, measuring 110 feet in length by 50 feet wide; the height of this hall is 50 feet.

In modern buildings Glasgow can boast of having the tallest chimney-stalks in the world. The great stalk at Messrs. Tennant's St. Rollox Chemical Works is 455½ feet in height from foundation to top, or 435½ feet above-ground. Its external diameter at base on ground-line is 40 feet, with a thickness of 2 feet 7½ inches; at top its



New Municipal Buildings.

external diameter is 13 feet 6 inches, with a thickness of 1 foot 2 inches. The chimney has a slightly-curved *batter* or rate of variation in width.

The chimney at Messrs. Townsend's Chemical Works, built 1857, is 468 feet high, of which 454 feet is above-ground. An extra height of ornamental iron work extends for 20 feet above the cope. The outside diameter at surface of ground is 32 feet, and at top 12 feet 8 inches; the thickness varies from 7 bricks at base to 1½ brick at top. The chimney has a straight *batter*.

This great stalk shortly after being finished was subjected to a severe storm which broke over Glasgow, and in consequence of the immense pressure of wind upon such a great surface it was visibly bent over. It became a question how to deal with it under such conditions, when finally a simple, and, as the result proved, an effective remedy was suggested, viz. that of sawing into the joints on the convex side. This was done, and the great chimney gradually settled back to its originally perpendicular position.

Up to within a few years ago these great stalks were, with one or two exceptions (the great spires at Vienna and Strasburg, and the Great Pyramid), the highest buildings in the world; but the Americans can now claim to possess a building which much exceeds previous structures, viz. the Washington Monument at Washington. This is an obelisk 555 feet high, built of beautiful white marble, and which, in the clear air of that city, can be seen a long distance off.

INSTITUTIONS.

Glasgow possesses many scientific and literary institutes, many of these, such as the Philosophical Society, carrying back a corporate record to the beginning of the present century. This Society was instituted in 1802, the first president being Professor Wm. Meikleham, LL.D.

The Institution of Engineers and Shipbuilders is a younger body, and was instituted in 1857 under the presidency of the genial and accomplished Professor Macquorn Rankine.

Geological, natural history, and other societies discuss questions relating to our solid globe and its inhabitants, archæological societies revive our interest in the past, while literary and educational societies discuss questions of a more general character. As educational institutions, more or less scientific in their character, the Andersonian, Mechanics' Institution, and Athenæum have long been well known, and many can look back with gratitude to the help which these places of learning afforded them when struggling to acquire some further information than a short school period had enabled them to obtain, and to advance in the special line of knowledge which they desired. Old students of the Mechanics' Institution will not readily forget the stirring addresses made at the annual meetings, when the prizes were presented by the late Sheriff Glassford Bell.

Anderson's Institution was founded in 1796 by Mr. John Anderson, Professor of Natural Philosophy in Glasgow University; and it has long been a centre of class-

work, lectures, &c. Classes for mechanics were early started in this Institution.

The Glasgow Mechanics' Institution was started in 1823, and in its first year had fully one thousand students on its roll attending the various scientific lectures and classes. This Institution changed its name in 1881 to that of College of Science and Arts.

The scheme recently drawn up by Commissioners appointed under the provisions of the Educational Endowment (Scotland) Act, viz. that Anderson's College, the Young Chair of Technical Chemistry in connection with that College, the College of Science and Arts, Allen Glen's Institution, and the Atkinson Institution should now be amalgamated as The West of Scotland Technical College has been carried out; and the work of these bodies, formerly under separate and independent government, is now administered by a body elected from the Town Council, the University, and various societies in the city, called Governors. Libraries are connected with all these Societies and Institutions, which, combined with the excellent and rapidly-growing public libraries of the city, afford ready means for mental improvement and recreation.

The Glasgow Observatory has for many years been located on Dowanhill. The original University Observatory stood in the old College grounds in High Street, and was built at the time when the chair of Astronomy was founded in 1760. There was an observatory erected in 1810 on Garnethill, which was divided into scientific, popular, and literary departments. It says a great deal for the scientific enterprise of the citizens of the early

years of the century that they founded this establishment by "individual subscription."

The comet of 1811, from which the first European steamer derived its name, was watched at this observatory, and particulars regarding its orbit, size, &c., deduced. Thus, its distance from the earth on 15th Sept., 1811, was estimated at 142,500,000 miles; distance from the sun, 95,253,840 miles; perihelion distance, 94,724,260 miles; length of tail, 33,000,000 miles. The magnitude of the nucleus, as determined by the great telescope of Herschel, which, it is said, stood on a terrace at this observatory, appeared like the full moon. The present observatory, ably presided over by Professor Grant, contains, beside the usual transit instruments, a fine equatorial, having an object-glass of 9 inches diameter and a focal length of 11 feet.

BRIDGES.

Looking at a map of the city for the year 1778 we see just two bridges, one at foot of Stockwell Street, leading to the "Gorbells"—a small district of about one or two streets, and at that time the only part built on the south side; another, called the "New Bridge," crossed the river at the foot of Jamaica Street, the most important building near it on the south side being a windmill near the river, and standing in the Windmill Croft.

Looking at another map of the city for the year 1818 we see three bridges shown, joining the north and south sides of the river. One at the foot of Saltmarket, one at the foot of Stockwell Street, and one at the foot of Jamaica Street. On the south side we now see various

streets and buildings divided into the districts of Hutcheson Town, Laurieston, and Trades Town. The windmill has disappeared, and amongst a few single-masted sailing boats we see a solitary steamer.

The bridge spanning the river from Saltmarket Street to Hutchesontown was at one time made of wood, and was built in 1803. This bridge was about 340 feet in length, having eight supporting piers; the width was only a little over 7 feet. It was raised up so much above the river—probably to allow flood water to pass underneath safely—that stairs were required at each end to get on to it from the roadway. Later on, a stone bridge was built about the same position. The inscription, coins, papers, &c., which were placed at the laying of the foundation of the stone bridge, are to be seen in the Kelvingrove Museum. In 1871 the present handsome Albert Bridge was erected. This bridge consists of three spans, one of 114 ft. and two of 108 ft. each; the width is 60 ft.; it is constructed of wrought iron. The piers are formed of cast-iron cylinders, sunk to a depth of from 65 ft. to 80 ft., through strata of sand, mud, and gravel, until the sandstone rock is reached.

A wooden bridge appears to have existed as early as the fourteenth century, as a stone bridge was erected by Bishop Rae in its place in 1345. This bridge spanned the river at the foot of Stockwell Street. The present bridge was built in 1851.

The old Jamaica Street Bridge was erected in 1767, and gave place to the present handsome building, designed by Telford, and founded 1833. In reference to this work of the great engineer (who, besides road-

making and ordinary stone-bridge building, successfully spanned the Menai Straits with his iron suspension bridge), Smiles, in his *Lives of the Engineers*, says: "But the most important, as it was the last of Mr. Telford's stone bridges, was that erected across the Clyde at the Broomielaw, Glasgow. Little more than fifty years since the banks of the river at that place were literally covered with broom—and hence its name—while the stream was scarcely deep enough to float a herring-buss. Now the Broomielaw is a quay frequented by ships of the largest burden, and bustling with trade and commerce. Skill and enterprise have deepened the Clyde, dredged away its shoals, built quays and wharves along its banks, and rendered it one of the busiest streams in the world. It has become a great river thoroughfare, worked by steam. On its waters the first steamboat ever constructed for purposes of traffic in Europe was launched by Henry Bell in 1812, and the Clyde boats to this day enjoy the highest prestige.

"The deepening of the river at the Broomielaw had led to a gradual undermining of the foundation of the old bridge, which was situated close to the existing landing-place.

"A little above it was an ancient overfall weir, which had also contributed to scour away the foundations of the piers. Besides, the bridge was felt to be narrow, inconvenient, and ill-adapted for accommodating the immense traffic passing across the Clyde at that point. It was, therefore, determined to take down the old structure and build a new one, and Mr. Telford was called upon to supply the design. The foundation was laid

with great ceremony on the 18th of March, 1833, and the new bridge was completed and opened on the 1st of January, 1836, rather more than a year after the engineer's death. It is a very fine work, consisting of seven arches, segments of circles, the central arch being 58 feet 6 inches; the span of the adjoining arches diminishing to 57 feet 9 inches, 55 feet 6 inches, and 52 feet respectively. It is 560 feet in length, with an open waterway of 389 feet; and its total width of carriage-way and foot-path is 60 feet, or wider, at the time it was built, than any river-bridge in the kingdom."

Some years ago, after the removal of the weir above referred to, it appeared that the increased scour due to this removal, or to the constant dredging operations going on below, was affecting the foundations of the piers of the bridge. These foundations had been made on piles sunk into the bed of the river, which at this part consists mainly of silt and sand. Steps were accordingly taken to strengthen the parts required. This was effected by placing aprons of concrete around the foot of the piers. The roadway referred to above as being noticeable for its width has long been felt to be insufficient for the immense traffic which daily crosses the bridge.

The railway bridge erected by the Caledonian Railway to carry that line into the Central Station, is situated immediately below the Glasgow Bridge just referred to. It consists of three spans of lattice-girders resting on iron piers sunk in the river bed until a sufficiently solid foundation was reached; in this case the depth of loose material, silt, sand, &c., which had to be penetrated was as much as 80 feet. The bridge carries four lines of

rails. The contractor for the erection of this bridge, Mr. Wm. Arrol, like his great predecessor Telford, has made a name for himself as a bridge builder, the gigantic structures of the Forth and Tay Bridges having been intrusted to him to carry out. The successful completion of the Tay Bridge having just been accomplished, gives us the more assurance that in a short time we shall see the projecting arms of the Forth Bridge stretching their 1700 feet of steel framework across the deep and fast-flowing waters of the Forth. Mr. Arrol has the inventive faculty and ready resource of the early engineers and builders who have laid the foundation of our engineering celebrity as a nation.

Another railway bridge, carrying the Glasgow and South-Western traffic, spans the river below the Albert Bridge. Like the Caledonian Railway Bridge further down, the girders are of the lattice type and carried on piers. A suspension bridge above the Jamaica Street Bridge, and another higher up connecting the Green with the south side, completes the existing number of Glasgow bridges. The cross traffic is, however, so great, that proposals are occasionally made and discussed as to additional facilities further down the river than Glasgow Bridge, whether by subways, high-level bridges, or other special means has as yet not been decided.

In the meantime the ferry traffic for passengers is admirably conducted at various points in the harbour and further down by means of steam ferry-boats having a screw propeller at each end, thus rendering turning unnecessary.

Bridges, like ships, are indispensable as links of com-

munication, and from an early period have had much attention paid to their design and construction. With the introduction of the railway system a great development took place in bridge building, and as in many cases the spans required and sites to be occupied were of such a nature as to prohibit the use of stone or wood, iron was employed, and a new form of structure gradually appeared, differing much in design and construction from the old stone arch. The tubular-girder bridges across the Menai Straits, and the St. Lawrence at Montreal, are great examples of a special form of structure adopted by Robert Stephenson, who with his father George were the early pioneers of the railway system.

Brunel, noted for his daring genius, bridged the Tamar at Saltash with two bows of 433 ft. span made hollow in section, and connected at the ends by chains, which, acting as ties, resist the thrust through the bow due to the load, somewhat as in the later "bowstring" form.

Zigzag, or "Warren" girders, lattice-girders, and arch-rib structures all followed in rapid succession. Suspension bridges with supporting medium of chains or wire-ropes were flung across wide and deep ravines where scaffolding could not find a place. And now at the present time, thanks to the skill of the steel manufacturer, the engineer has placed at his disposal a material which enables him to take still wider leaps than his predecessors, and project bridges across wide and dangerous rivers and estuaries which a few years ago would have been deemed almost impossible. Steel as now manufactured readily lends itself to these requirements, as from its now well-established reliability, great tenacity, and ductility,

it is well adapted to railway bridges, as the strength can be easily varied in the manufacture to suit any special demands by the engineer.

The great structure now erecting across the Forth at Queensferry is designed on the cantilever system; it is composed of steel and the great spans are being thrown out without the aid of scaffolding. This bridge will have two main spans of 1700 feet each. The largest bridge span at present is that of the East River Bridge, New York. The main span is on the suspension principle, and is 1595 feet 6 inches wide. There are four cables, each of which contains over 5000 parallel steel wires carefully wrapped together.

The Broomielaw.

PARKS.

Glasgow is well supplied with parks. The Green, bordering the river above the bridge, has long been a favourite place of recreation for the citizens and for assem-

blies of a civil or military character. More than a hundred years ago Wilson gives us a picture of a review on the "Green:"

> "The Clydesdale heroes bright in arms are seen
> To rival Rome's in force and awful mien;
> While, robed in red, fierce flame the lengthened lines,
> From their bright arms a dreadful splendour shines;
> While tubes that distant drive the death unseen,
> Or gleaming swords flash terror o'er the Green."

And since the first enrolment of a volunteer force in 1795, we have had many displays of the citizen-soldiers' drill, and the evolutions of the yeomanry, together with the military displays of the "regulars."

The Kelvingrove or West End Park was laid out by Sir Joseph Paxton about 1854, and is beautified by walks and drives along the slopes rising up to Park Terrace, from which extensive views of the valley of the Clyde can be had. Indeed on a fairly clear day the eye can range from Ben More in Glen Dochart to Goatfell in Arran, whilst the Dunoon and Lock Eck hills bound the western horizon.

From the Queen's Park on the south side of the river a complete and comprehensive view of the Clyde valley can be had, with Glasgow lying stretched around, curtained by a haze of smoke from its innumerable chimneys, both domestic and manufacturing. When the smoke nuisance is abated in Glasgow the visitor will then be able to admire the regularity and handsomeness of its street architecture. At present he may study individual buildings, but no fine vista opens out as it might

do if the atmosphere were clearer than it usually is in the busier part of the city.

From the Alexandra Park at the east end of the city fine views of the Clyde valley as far as Tinto can be had,

Tinto, near the source of the Clyde.

the latter conical hill standing out distinctively thirty miles to the east.

The districts of Govan and Partick have also now their parks, showing the increase of population in the outskirts.

The parks are made attractive to the citizens and visitors by a varied and tasteful ornamentation of shrubs and flowers, the latter arranged in a harmony of colour which delights the eye; whilst in summer bands of music at intervals perform selections from suitable stands around which crowd the old and young, the grave and gay.

At the present time the lower part of the Kelvingrove

Park is being covered over with the buildings for the Glasgow International Exhibition of 1888. The domes and pinnacles of the temporary home of the industrial products of our nineteenth-century civilization and mechanical skill rise above the long line of buildings which are grouped almost at the feet of the University on Gilmourhill, whose high tower with its now finished spire grandly towers over all. This is a fitting association of the halls of learning and the products of the workshop, the home of philosophy with its cultured professors and eager students, and the courts of the Exhibition filled with the products of the artificer, around which circulates the stream of active life. Here we see once again, after more than a century has passed away, that association of the college and the workshop which led to such mighty consequences in that far-back time when James Watt in his little workshop within the privileged walls of the old college in High Street, in repairing the old Newcomen engine of the natural philosophy class, devised the separate condenser, an invention to which so much of this grand industrial collection is due. It seems, therefore, fitting, after so many generations have passed away, during which even the old college has left the grimy shades of the High Street and reared itself wider and grander on the breezy slopes of Gilmourhill, that the industrial products of the world should be spread around it, as if in recognition of its early work in the field of philosophy and science, and of such names as Simpson, Black, Adam Smith, and Watt.

WATER SUPPLY.

Up to the year 1860 the greater part, or north side, of Glasgow was supplied from the river. The water was taken in from the stream above a bend in the river beyond the Dalmarnock Bridge, and after being filtered was pumped up to reservoirs in different parts of the city, such as at Drygate, Rottenrow, Garnethill, and Cranstonhill. There were altogether three pumping stations and thirteen pumping engines, placed as follows :—Seven at Dalmarnock, four at Cranstonhill, and two at Drygate. Two of the engines at Dalmarnock were very powerful, and went by the names of "Samson and Goliath." They were on the Cornish principle, with cylinders of 72 inches diameter and 10 feet stroke. *Samson* could elevate 3,000,000 gallons a day, and *Goliath* 5,500,000 gallons; the latter, however, supplying the low-level districts, did not work against such a back pressure as Samson. These old works have the special interest that the filtered water was originally carried across the river to the pumping engines by means of a 15-inch spherical-jointed pipe, designed by James Watt.

The Gorbals Water Works were started in 1845. The water is drawn from the drainage area lying on the hill slopes to the south of Glasgow, and stored in artificial reservoirs, situated about six miles from Glasgow and at varying heights above the city, generally about 300 feet above ordnance datum. The average rainfall is about 45 inches, and the quality of the water flowing off the trap-rocks which compose the hills is pure, the analysis giving:—

	Grains per Gallon.
Organic Matter, ...	1·531
Carbonate of Lime, ...	1·152
Sulphate of Lime, ...	0·946
Sulphate of Magnesia, ...	0·284
Muriate of Magnesia, ...	0·344
Alkaline Chlorides, ...	0·720
Oxide of Iron, ...	0·043
Silica, ...	0·177
Total, ...	5·197
Hardness, ... 3·2°	

The water is filtered and supplied to the city in cast-iron pipes 24 inches diameter.

Like the improvements on the river, the water supply of the city has had the benefit of much wide and varied experience. In the old days the public wells were the sources from which the inhabitants drew their supplies. The earliest attempt to organize a supply—limited, indeed, but still effective so far as it went in the then small area—was that by a Mr. Harley, whose baths and byres are still spoken of by old residenters. Mr. Harley started a supply station about the head of West Nile Street, and sent the water which had been pumped into a reservoir out through the town for sale.

In 1806 a company was formed, called the Glasgow Water Works Company, who brought in a supply from a point on the river a few miles above the city. In 1808 another company was started, called the Cranstonhill Water Works Company, who secured ground at Cranstonhill, where they made reservoirs, the water for which was pumped from the Clyde in the neighbourhood. Later on they removed the pumping station further up the river.

After about thirty years of competition the two companies were amalgamated. In 1855 the works of the Glasgow and Gorbals Water Companies were taken over by the Town Council, and the Loch Katrine Water Works opened in 1860.

For a long time previous to that date the Town Council had been moving for a better supply to the city, they having instituted a series of surveys of the available resources around Glasgow. Various reports were handed in by the skilled engineers employed, the districts considered lying more or less around the city. Thus in 1834 the Earn Water, to the south of the city, was proposed. In 1836 the North Calder and the Avon, several miles up the valley of the Clyde, and two of its tributaries, were brought forward. The engineer of this scheme was Mr. Robert Thom, who introduced water-power at Rothesay for factory purposes, and carried out the Shaws Water Works, for the supply of Greenock.

In 1837 another scheme was proposed, the water in this case to be drawn from the district lying south of Paisley. Later on a scheme to pump water from Loch Lomond appeared; another had the River Endrick as a source of supply, while in 1844 a proposal came forward to utilize the Clyde itself, but above the Falls.

These schemes coming to nothing, a company was formed in 1845, who constructed the Gorbals works for the supply of the part of the city lying on the south side of the river. In the same year we find a company started, of which Mr. Lewis Gordon, the first professor of civil engineering in Glasgow University, and Mr. Laurence Hill, were the engineers. This scheme was the first

bold public proposal to tap the Highland lochs lying far to the north of the city, the loch selected—Loch Katrine—being the one from which the city now draws its pure and plentiful supply. This proposal had influential support, and was only withdrawn on the Glasgow Water Company arranging to bring in a supply from Loch Lubnaig, a large loch near Loch Katrine. It was afterwards found that the Loch Lubnaig scheme was unworkable, and nothing was done.

Besides some of the names mentioned as engaged in the various proposals brought forward, we find that of Professor Rankine, the amiable and learned successor of Professor Gordon in the civil engineering chair of the Glasgow University. Dr. Rankine, along with Mr. John Thomson, in 1852, again brought forward the Loch Katrine supply scheme. After about two years of further proposals the Town Council managed to get the Loch Katrine scheme passed by Parliament, the Glasgow and Gorbals works having passed into their hands.

Loch Katrine, celebrated by the genius of Sir Walter Scott, is a loch of about seven miles in length, lying among the schistose hills of the southern part of the Perthshire Highlands. Its elevation above sea-level is about 360 feet. The water is very pure and abundant, as the rainfall of the district is high, being nearly 100 inches per annum. The level of the loch was raised 4 feet by a masonry wall at the outlet where the river Teith emerges. A tunnel, $1\frac{1}{3}$ mile long and 8 feet in diameter, was driven through the outlying spurs of Ben Venue, after which the aqueduct runs through a rough and out-of-the-way district, passing not far to the west of Loch

Ard, famous as the scene of Bailie Nicol Jarvie's adventure and encounter with the Highlandmen at Aberfoyle, the coulter of the plough which he is said to have used so successfully in its red-hot state being still on view to the eyes of the curious, hanging from a tree opposite the inn.

The contractors had a hard time of it; dynamite was not then in the market, and gunpowder was the strongest ally they could employ against the old metamorphic rocks.

Bridges, cast-iron troughs, cuttings in rock and earth, piping, &c., were required to carry on the line until the Endrick valley was reached, when a four-foot syphon pipe, $2\frac{1}{4}$ miles long, was laid. Another large tunnel, about $1\frac{1}{2}$ mile in length, had to be driven through the high ground to the north of Milngavie, after which the aqueduct terminates at the Mugdock Reservoir—in all, a distance of about 26 miles.

The Mugdock Reservoir is situated 317 feet above sea-level, and contains 548,000,000 gallons. The water leaves the reservoir by two main pipes, each 42 inches diameter, and which were calculated to deliver the total daily supply for which the works were constructed, viz. 50,000,000 gallons; thereafter two 36-inch pipes continued the line to the city, about seven miles distant.

The total cost of the works was £918,000. They were begun in 1856 and finished in 1859, being opened by Her Majesty the Queen in person on the 14th October, 1859. The engineer was Mr. J. F. Bateman, of London.

Additions were afterwards made by laying extra piping, so that the whole estimated supply might be made available; and now, the city has grown so rapidly that at the

present time additional works are in progress, designed by the Corporation Water Works engineer, Mr. J. M. Gale, whereby the originally contemplated fifty million gallons per day—which is now nearly all required to meet present demands—may be about doubled, so as to meet the wants of many years to come. These works necessitate other tunnels being driven and additional piping laid, and another service reservoir at Mugdock.[1]

An analysis of the Loch Katrine water, made by the late Dr. Penny in 1854, gives as follows:—

	Grains per Gallon.
Organic Matter, ...	0·900
Sulphate of Lime, ...	0·381
Chloride of Calcium, ...	0·144
Alkaline Chlorides, ...	0·433
Carbonate of Magnesia, ...	0·216
Sesquioxide of Iron, ...	trace.
Silica, ...	0·170
Total, ...	2·244

Hardness, on Dr. Clark's scale, ... 0·8°

Gases per Gallon.	Cub. Ins.
Carbonic Acid, ...	0·080
Oxygen, ...	2·424
Nitrogen, ...	4·777
Total, ...	7·281

[1] For a graphic description of the "Glasgow Water Works, by Mr. James M. Gale, C.E., Engineer Glasgow Corporation Water Works," see *Trans. Inst. Engineers and Shipbuilders*, vol. vii., to which the author is indebted for the greater part of the facts in this description. It may be interesting to note that Professor Rankine, in the discussion of the paper, remarked "that although Mr. Thomson and himself had tried to improve their plan in its details, Messrs. Gordon and Hill were specially to be remembered for their having discovered

From one of the monthly reports (September, 1887) of the quality of Loch Katrine water, prepared by Professor E. J. Mills, D.Sc., F.R.S., Anderson's College, the results are returned in parts per 100,000:—Total solid impurity, 2·50; organic carbon, ·151; organic nitrogen, ·021; nitric nitrogen, ·004; ammonia, ·000; total combined nitrogen, ·025; hardness, ·95; chlorine, ·70. Temperature, 13·0 degrees C.=56·40 degrees Fahr.

CHARITIES, &c.

"Linlithgow for wells, Glasgow for bells." So rhymes the old couplet. The bell has long been associated with the arms of the city, the motto "Let Glasgow Flourish, by the preaching of the Word" being, it is said, derived from a pious aspiration inscribed on the bell of the Tron Church. The sound of the church-going bell is weekly wafted across the great city from many a tall spire on Sundays, when the great workshop wheels cease to run, and the thousand engines stop for a while their weekly efforts, and the toiling workers, whether by hand or brain, may find rest for the body and elevation of the soul, undisturbed by the feverish bustle of the busy week through which they have passed. Glasgow is a city of churches, from the noble old Cathedral with its long-drawn aisles along which the organ peals, and its gray walls illumined here and there by beams of light through the stained-glass windows, to the humble meeting-house of earnest

that there was a point in the ridge between Loch Katrine and the valley of Loch Ard where a tunnel could be driven through the hill. That was, he thought, the great original discovery which showed the Loch Katrine Water Works to be a practicable scheme."

souls seeking to serve God as they believe right; for fortunately we live in an age when religious freedom is a recognized right of the people, unlike times not so far passed away, and which had existed for generations further back, when such mottoes as these were written, and may still be read, carved in quaint old letters on door lintels.

> "Sen . vord . is . thrall . and thocht . is . fre .
> Keip . weile . thy . tonge . I coinseil . the ."[1]

The local charities of Glasgow are wide-spread, and as the years roll on one after another is added to the list.

When Pennant visited the city in 1772 he mentions, amongst other features of interest, the Trades House, composed of fourteen incorporated trades, of which the Deacon Convener is head, and which maintained the poor and settled disputes.[2] The Merchants' Hospital, founded in 1601, having a large capital to support the poor.[3] The Town's Hospital containing at his time 400 indigent persons. Hutcheson's Hospital, founded in 1642 by the brothers of that name, and also a large Alms House near the river.

In the first Glasgow Directory, published 1787, we find one or two additional charities mentioned, viz.:—St. Nicholas Hospital, of which the magistrates of Glasgow were part directors; Blair's and Scot's Tarbet's for boys; and Wilson's Charity. In a directory of the

[1] On old house in Maygate, Dunfermline.

[2] The revenue of the Trades House during the year ending in 1887 was £4399; of this about £2800 was paid away in pensions, whilst about £1500 was spent on education and subscriptions.

[3] The yearly revenue of this institution is about £8000 for benevolent purposes.

present day we find about 100 entries under the title of CHARITABLE AND FRIENDLY INSTITUTIONS, some of the more recent of which are for the succour of poor children, and for the nursing of them in sickness; and following the teaching of the "Ancient Mariner," that

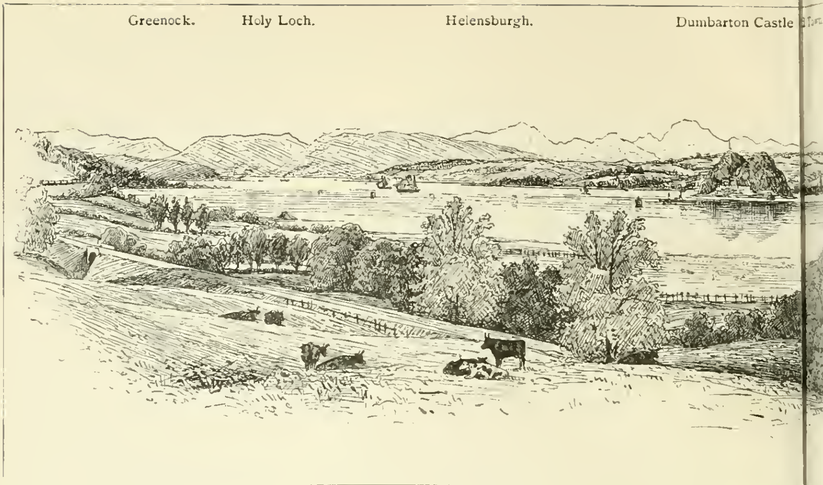
> He prayeth well, who loveth well,
> Both man, and bird, and beast,

we find also such meritorious associations as that of the Society for the Prevention of Cruelty to Animals.

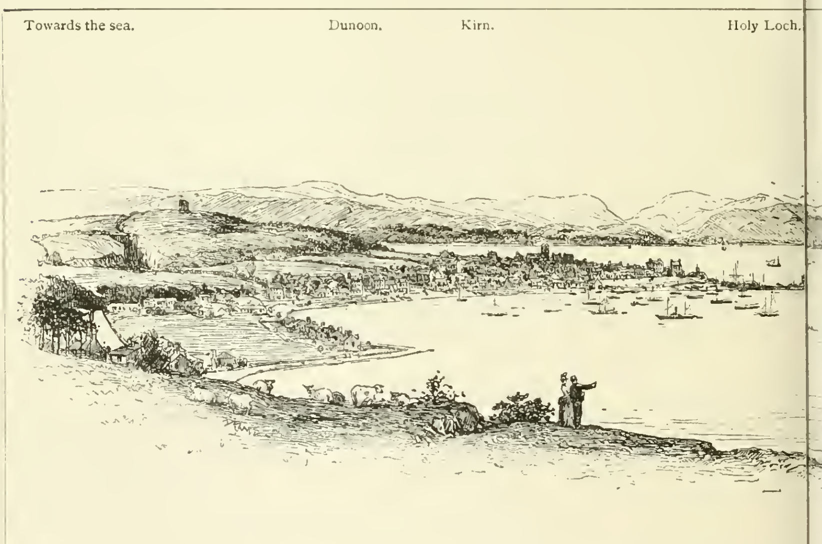
If the traveller to the coast passes down to Greenock by the Glasgow and South-Western route, he may notice, between the Bridge of Weir and Kilmalcolm, a cluster of houses, a church, and, strange sight in these upland districts, the masts of a ship, with the hull showing the well-known British white-painted side-ports, sailing, as it were, on dry land. This establishment or colony, quietly lying at the foot of the hills and by the waters of the Gryfe, is, we may say, an embodiment of the power of faith. "The Orphan Homes of Scotland," "The Destitute Children's Emigration Homes," and the "City Home and Mission," were originated in Glasgow sixteen years ago by Mr. William Quarrier of that city. This movement to reclaim the orphan and outcast children of the city streets had a small beginning, but has been carried on successfully by the originator, now assisted by many devoted workers, in the spirit expressed by himself in his annual report:—"We never call on anyone for money, nor do we send out collectors, or resort to bazaars or entertainments, to raise it. The work is the Lord's, and we commit *everything* to Him in prayer, believing that He will supply

through His children what we require; and hitherto this has always been the case." The doors of this Christian mission are always open, and, unlike most other charities, no subscriber's line is necessary for admission, no really *destitute* orphan child being refused. The extent of this mission may be realized from the fact that during the year 1887 over twelve thousand pounds sterling have been received, together with large quantities of much-needed clothing and provisions. During the year about 1000 children have passed through the homes, besides hundreds of others who have met with much-needed help and Christian advice. Contingents of the children from time to time proceed to Canada, where, in the wider field for service in that as yet comparatively sparsely-peopled Dominion, homes are readily obtained for the young emigrants, and where many are now living useful and industrious lives.

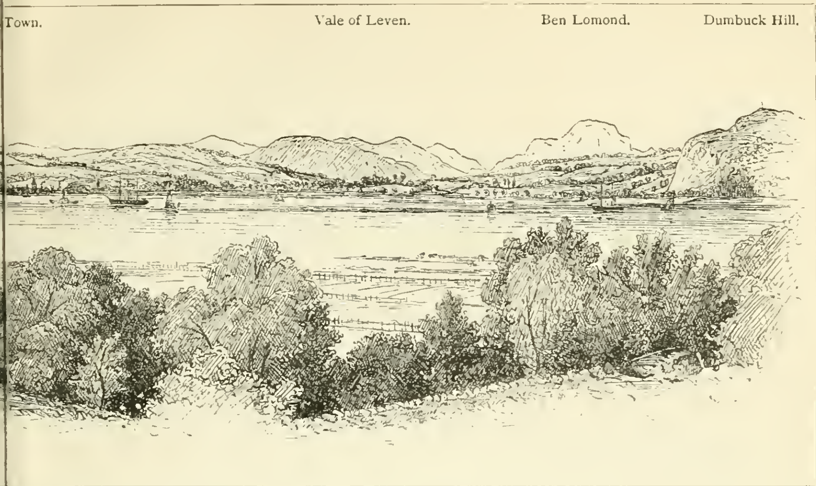
The various departments of this Christian philanthropic mission consist of the City Orphan Home and Mission Hall, James Morrison Street, in Glasgow. The Orphan Homes of Scotland, Bridge of Weir, consisting of twenty-six buildings erected at a cost of £70,000, presented in many cases by individuals. The Bethesda Home for Incurable Children, Bridge of Weir; Training Homes for Boys and Girls for Canada, Bridge of Weir; Canadian Distributing Home, Fairknowe, Brockville, Ontario, Canada; and "The Ship on Land," for training boys to become missionary seamen, at Bridge of Weir. The Ship on Land was presented by a wealthy donor. She is called the *James Arthur*, is a full-rigged brig, and measures 120 feet in length by 23 feet in breadth, and



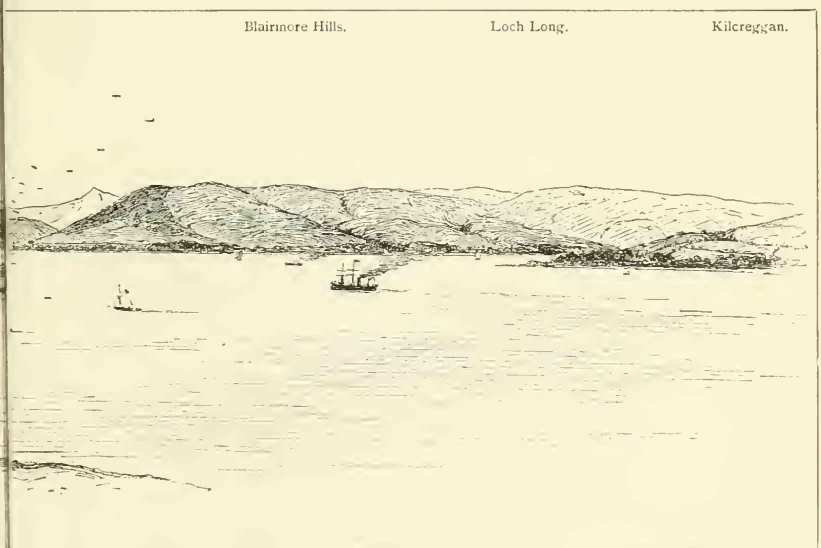
THE CLYDE, AS VIEWE



GOUROCK BAY AND FIRTH OF CLYDE, FROM



ROM NEAR FINLAYSTON.



HEIGHT BETWEEN GREENOCK AND GOUROCK.

has a height between decks of 9 feet. The vessel is built of iron, cost about £3400, and is fitted up with gear and stores as if for a voyage. A captain and officers are in command of the ship, and the crew of about 30 boys. A complete system of navigation is taught in the schools on board. The boys also have the advantage of some actual seamanship in boats on the neighbouring river Gryfe.

As the traveller passes onwards towards Greenock, he will find himself rapidly descending the slopes above the Clyde, with a perfect panorama of mountain and valley, sea and sky, spread before him. Dumbarton Rock, Ben Lomond, the far-off mountains of Argyleshire, the river below with its sailing vessels and steamers, the distant smoke of Greenock, and the shipping at the "Tail of the Bank." If his eye is fairly good he may notice beyond the town of Helensburgh, and almost in shadow of the woods of the ducal seat of Roseneath, a three-masted square-rigged ship, lying as if to guard the entrance to the Gareloch; the ship is the *Cumberland*, serving as a training-ship for boys. The movement of which this vessel is the outcome originated about twenty years ago amongst several gentlemen connected with the city of Glasgow, at a meeting held in Glasgow, in November, 1868, and presided over by Mr. John Burns of Castle Wemyss. The object of the meeting was stated to be the "establishing of a training-ship for boys on the Clyde, under the provisions of the Industrial Schools Act 1866." Later on this resolution was followed up by an appeal to the Lords of the Admiralty, showing that while much had been done in the district by means of industrial schools, the memorialists were desirous

of still further extending this work, and more especially with the view to the material advantage of the mercantile marine service, by educating boys to become efficient seamen, for which purpose the memorialists desired the Admiralty to grant them a suitable ship in which the work could be carried on.

The desire of the memorialists was granted, and the Admiralty presented the *Cumberland,* an old line-of-battle ship of seventy guns, which was launched at Chatham in 1842, had carried the British flag on the North American coast, the West Indies, and during the Russian war formed part of the Baltic fleet. After serving her Queen and country on the ocean the *Cumberland* cast anchor at the mouth of the Gareloch on 30th May, 1869, as training-ship for the Clyde and the west of Scotland. Her principal dimensions are: length 216 feet, breadth 54 feet, and she is 2214 tons burthen. The *Cumberland* since her establishment as a training-ship in 1869 has received about 3000 boys, these passing away from time to time to active service. There are generally about 400 on board, who receive a complete educational as well as a specific training for their after-life, the latter consisting in studying navigation, practice of seamanship, gunnery, &c. A tender has now been attached to the *Cumberland,* called the *Cumbria,* about 60 or so of the boys going off at intervals on board of this vessel, a brig, for cruising purposes. The work is kept up financially by a government grant supplemented by annual subscriptions. These boys, who must be under fourteen years of age, are drawn from the vagrant class so widely spread unfortunately in big cities.

It appears that an incident in connection with the manning of one of our war-ships so far back as the year 1756, in which a number of the London city waifs were collected and sent to Portsmouth to fill up the *Barfleur*, about to join the blockading squadron off Brest, brought about the establishment of the Marine Society in the same year, for the purpose of gathering such boys, attending to their wants, and transferring them to various vessels as required. The idea of a training-ship was first carried out in 1786 by this society, a small vessel being purchased for the purpose and placed on the Thames, to be replaced later on by a disused war-ship. This filling up of war-ships in these stirring times was accomplished forcibly, through the work of the press-gang, official announcements of the results appearing in some of the newspapers at the close of last century, telling us that a "warm press" had been made in which "prime and ordinary seamen were taken."

Farther down on the shores of the Firth, where the invigorating ozone in the sea-breeze puts new life into the wearied and sickly frame, are Convalescent Homes, such as that at Dunoon, originally promoted amongst other charitable institutions by Miss Beatrice Clugston of Glasgow. The Sick Children's Hospital in that city, for which "The Fancy Fair" was held in St. Andrew's Halls in 1884, was another special movement whose success was largely due to Miss Clugston's untiring labours, and of which it is recorded that "To Professor Cowan, with whom the movement originated, and to Miss Clugston, who by earnest speech and writing pleaded for sick children, special acknowledgments are due."

From an epitome of the history of the Savings-bank we find that after some preliminary meetings the bank started business on July 30, 1836, 391 accounts being opened in the first week. In 1840 Mr. Wm. Meikle was appointed accountant, and in 1849 actuary. In 1846 depositors numbered 23,450; funds, £412,086. In 1851 property was purchased at the north-west corner of Wilson Street, which had been previously occupied by the Paisley Bank and the City of Glasgow Bank. In 1856 depositors were 32,873; funds, £664,996. In 1857, owing to a commercial panic, the bank paid over in one day £28,000, about three times more than usual. In 1865 the present site was purchased. In this year the number of depositors had risen to 51,598; funds, £1,120,000.

This bank, largely through the able management bestowed upon it, is now the largest in Great Britain, the transactions for the year 1886 being as many as 447,375, made by 103,269 depositors, whose total funds amounted to over £3,000,000. In this work the head office is assisted by four branches in the various quarters of the city. It is interesting to note that the total funds or assets of the bank are increasing in a very rapid ratio, indicating that there is a spirit of thrift abroad amongst the working community, for whom the bank was originally intended, and that the excellent management of its affairs has given a good guarantee of security to the depositors. It is further somewhat curious to observe that the total funds are almost doubling every tenth year; in other words, increasing approximately in geometrical progression.

POPULATION AND AREA.

Glasgow as a city has rapidly extended its boundaries, and as the years of its history have gradually rolled along, places which once were independent centres with a jurisdiction of their own have been, one by one, assimilated and incorporated into the municipality now existing. Again, as the advance of the city continued, districts which had sprung up on the outskirts were gradually overtaken, and the area now covered by the actual municipal city and the wide-spread and now practically continuously united outskirts, has grown to about 20 square miles in extent. This condition of things at the present time has called for careful consideration, as, although the various newer suburban districts are managed under the Police Act, it is believed by the city authorities that greater efficiency and harmony of action would arise if the municipal boundaries were extended to meet the state of affairs which has gradually grown up.

In a statement recently prepared by the Glasgow Town Council and laid before the Glasgow Boundaries Commission it is shown that, since the parliamentary boundaries were fixed in 1832, the population and rental have nearly trebled; and further, that the present population is about one-sixth of that of the whole of Scotland. The population at present of the city within the municipality is estimated at about 544,000. The population of Glasgow in 1614 was about 8000; in the year 1740, or about a century and a quarter later, the population had fully doubled; about 1770, or only

thirty years later, it had again about doubled. In 1791, or about twenty-one years later, another duplication had taken place, the population at this date being 66,578, or fully eight times what it was in 1614, one hundred and seventy-seven years previous. The next duplication was between the years 1811 and 1821. In 1811 the population had reached fully 100,000. A rapid increase now took place in the next ten years of nearly 50 per cent, the population in 1821 having reached the figure of 147,043. Since that time the percentage of increase per ten years has been much less. The following are the figures during the present century:[1]

Year.	Population.
1801,	77,385
1811,	100,749
1821,	147,043
1831,	202,426
1841,	255,650
1851,	329,096
1861,	395,503
1871,	477,732
1881,	511,415
1887,	543,995 estimated.

The population for 1887 is as estimated in connection with the Glasgow Boundaries Commission held in November and December, 1887. If to this be added the population of the suburban burghs, estimated at 187,122, we have a total population in the city and suburbs of 731,117. The rapid extension, with the increase of property, is lucidly brought out in the statement

[1] *Vital, Social, and Economic Statistics of the City of Glasgow*, by James Nicol, City Chamberlain.

submitted by the Town Council to the Boundaries Commissioners, and published in the *Glasgow Herald*, thus:

"As a consequence of the increase of Glasgow, which since 1840 has proceeded in a manner probably unexampled in Great Britain, various suburbs have sprung up beyond the Parliamentary boundaries, and are in reality part and portion of the city. Although ample provision was believed to have been made by the Boundaries Commissioners of 1832 for future large extensions, the actual growth of Glasgow within the last fifty-five years has far exceeded the expectations of the Commissioners. It has pushed itself westward nearly 2 miles beyond the Kelvin, uniting itself to and going beyond the village of Partick; it has extended to the north-west, so as to include the village of Maryhill; while the district on the north, known as Possil, is being rapidly built over; the ground between Maryhill and Partick, to a distance of nearly 2 miles west of the Kelvin, known as the Hillhead and Kelvinside districts, is either already occupied or is being rapidly covered by the residences of the wealthier citizens. South of the Clyde, Glasgow has united itself to and gone beyond the village of Govan, and has extended over the districts known as Kinning Park, Pollokshields, Govanhill, Crosshill, Polmadie, Mount Florida, Langside, Shawlands, Crossmyloof, Strathbungo, and Bellahouston. As showing the increase of Glasgow within its municipal limits, it is stated (1) that while the population, as given in the report of the Boundaries Commissioners of 1832, was, in 1821, 147,043, and in 1831, 202,426, the census of 1871 shows it to have been 491,495, and the census of

1881, 511,415. At the present time (1887–88) it is estimated to be 543,995. (2) The report of the Boundaries Commissioners also gives the number of houses within the city in 1821 as 33,805, and in 1831 43,513; in 1871–72 they numbered 103,633; in 1878–79, 118,300; and in 1887–88, they are estimated to number 122,043. The rental of lands and heritages within the city cannot be given authoritatively previous to 1854, when the Valuation of Lands (Scotland) Act was passed, and for the first time established a uniform mode of valuation. In 1855–56, however, the valued rental was £1,362,178; in 1878–79 it was £3,418,322; and in 1887–88 it is £3,336,964. The population resident in the suburbs of Glasgow beyond the Parliamentary and municipal boundaries was estimated in 1878–79 to be 140,493; in 1887–88 it is estimated to be 187,122. The number of dwelling-houses in these suburbs in 1878–79 was estimated at 33,794, and in 1887–88 it is estimated at 41,040. The valued rental in 1878–79 was estimated at £901,152; in 1887–88 it is estimated at £1,058,516."

It is gratifying to find that, notwithstanding this rapid increase in the size of the city, the death-rate should be lessening, a hopeful sign that the increased improvements in the construction of houses, width of streets, plentiful supply of pure water, and close attention to sanitary matters, together with the increasing skill of our physicians, has enabled the citizens to bear the strain of a great industrial centre better than their forefathers. Speaking of this Dr. Russell, the medical officer of health for the city, says: "The death-rate of Glasgow has been improving. Previous to 1871 the aver-

age death-rate was 30; from 1871 to 1880 it was 26; in 1885, 26; 1886, 25; and during the present year 23."

In connection with this it may be interesting to notice the influence of a rapid change of temperature as affecting the death-rate, and to which reference was lately made by Dr. Russell in dealing with the health of the city about the middle of October, 1887: "The death-rate in the first week of the fortnight was 23, and the mean temperature 39° F.; in the second week 18, and the mean temperature 46° F. This sudden rise of the death-rate with the sudden fall in temperature was an illustration of the extreme sensitiveness of our population to cold, and a warning of what might be expected if a severe winter, especially with fog, followed the warm and genial summer of this year. The deaths and mean temperatures of the last four weeks were as follows:—50° F., number of deaths 172; 49° F., ditto 188; 39° F., ditto 236; 46° F., ditto 185; so that a fall of 10 degrees in the mean temperature added at once 48 or 41 per cent to the number of deaths, which was immediately taken off by the rise of 6 degrees in the next week. Although the fall in temperature was general and very uniform over Scotland, there was no such proportionate effect exercised on the other chief towns."

Glasgow has not been the scene of so many stirring historical events as its sister city Edinburgh; still, from the time of Wallace's struggle for the freedom of his country, when he made a dash at the English garrison in the Castle of Glasgow, onwards, we find that Glasgow has heard the roll of the war-drum on several occasions. About the middle of the sixteenth century the castle was

again a point of attack, during the regency of the Earl of Arran, who appears to have attacked this stronghold in the cause of the future Queen Mary, what was known as the Battle of the Butts being fought and won by this nobleman, whose army afterwards entered Glasgow.

The battle of Langside, which resulted in the overthrow of the unfortunate Queen Mary, was fought in 1568 at a place near Glasgow at that time, but now covered with streets and the villas of the citizens. Glasgow appears to have favoured the party opposed to the Queen, as we read that the Regent Murray showed his gratitude to the citizens for their help. After the victory at Langside he returned to Glasgow and bestowed on the Incorporation of Bakers a charter, whereby certain lands on the bank of the Kelvin were granted them for the building of a mill, so that they might grind wheat for their own use, and this on account of the liberal supplies of bread with which they had provided his army.

In 1645 the Marquis of Montrose, after the battle of Kilsyth, entered Glasgow; and Cromwell in 1650 established himself for a short time in the city, living, it is said, in a house in the Saltmarket.

In 1678 the Highland Host entered Glasgow on their way south to suppress the conventicles or meetings of the Covenanters, and they get credit for disturbing the peace of the town and plundering the inhabitants.

Again in 1679 a struggle took place after the battle of Drumclog in the streets of the city, between Viscount Dundee and the Covenanters, followed shortly afterwards by the battle of Bothwell Bridge.

In 1715 the citizens declared for the Hanoverian cause

raised an army, and fortified the city by intrenchments during the disturbed period, from the standard of the Stuarts being set up by the Earl of Mar, until shortly after his defeat at Sheriff-muir. And again in the '45, when the Stuart cause for a short time was revived and the clans rallied round Prince Charlie, Glasgow heard the wild music of the great war-pipe, and saw the targets and claymores of his devoted followers on their return from their incursion into England. They remained in the city for about ten days, Charles residing, it is said, in a house in the Trongate. A levy was made for articles of clothing, after which the Highlanders departed for the North, the Duke of Cumberland and General Wade, with the English forces and the supporters of King George, closing upon them, till, a few months afterwards, the decisive battle of Culloden was fought, and the Prince became a wanderer. As the sun of his short-lived day of success set amidst the clouds of misfortune there was heard from many a stricken home the wail arising:

> "Drummossie Muir, Drummossie Muir,
>   A waefu' day it was to me,
> For there I lost my father dear,
>   My father dear, and brethren three.
>
> Their winding-sheet the bluidy clay,
>   Their graves are growing green to see,
> And by them lies the dearest lad
>   That ever blest a woman's e'e.
>
> Now wae to thee, thou cruel Duke,
>   A bluidy man I trow thou be,
> For mony a heart thou hast made sair,
>   That ne'er did wrang to thine or thee."

Chapter VI.—THE RIVER.

An important feature in connection with both ancient and modern Glasgow is its river. Bounding it on the south in the early days, it now passes through it, the old Barony of Gorbals being absorbed, and streets extended far and wide along what was once grassy banks where the sheep pastured.

To go no farther back than what can be recalled by the memory of many citizens, we see a comparatively shallow stream, much subject to floods, crossed by three bridges having the high narrow roadway of the old builders. The Glasgow Bridge of those days, say sixty years ago, was not the handsome almost level structure of the present time, but rose high in the middle, with narrow footpaths, and a broad ledge outside of the parapet, along which the foolhardy youngsters of that time dared to walk.

On the lower side of the bridge an apron of causeway had been put to protect the piers from the action of the stream, and above this stonework the tide did not rise. So shallow was the Clyde at that time in the harbour that one who was a boy of that period tells the author that he easily waded across and rested himself on the paddle-wheels of the *Largs*, one of the early Clyde river steamers. The banks on the south side, below the bridge, were largely open fields where cattle pastured, and the old towing path by the margin afforded a pleasant promenade to the old gentleman of the period down by the fisher's hut to Govan.

The shallowness of the river at low-water was also so marked, that somewhere about the present Clyde Street Ferry the workers of the mills which were about Springfield used to wade across to their homes on the north side. The boys also sometimes attempted an opposition to the halfpenny ferry, which at that time existed, by swimming across with their clothes tied in a bundle on the top of their heads. Their nautical instincts also had opportunities of development in the quiet waters of the "Hem-in," where they sailed their boats. This pond, as somewhat implied by its name, was simply a part of the shallow water of the river on the south side, bordered and shut off from the Clyde by the towing-path: the water was used for a spinning-mill in the neighbourhood. Another amusement of these sixty-years-ago juveniles was to throw clods into the river and fish them out, perhaps on the following day, a large number of small eels having congregated about the clods in the meantime; these were taken home and placed in basins of water to edify the young naturalists and their friends.

At that time big posts were placed out from the bank to tie vessels to, and the small single-ladder dredger with its attendant punts did what it could to deepen the channel. To assist it in getting at the shallower portions near the river bank, an iron spoon-like machine with a long pole attached was dragged outwards by a windlass placed on a punt in deeper water. By this means some of the sand, &c., of the shallow parts was brought within the range of the dredger's buckets, which in turn transferred it to the punts; a windlass on the shore, with rope attachment, drew the spoon back again for a fresh start. Some-

thing like this spoon arrangement was the only method adopted for dredging the river at the time of Pennant's visit in 1772.

It is interesting to note that one of the early methods of scooping up the sharp river sand for building purposes still exists in full action above the Stockwell Bridge, where the passer-by may notice a strange flat box-like boat, with a mast, to which is slung a long pole or yard, which is frequently lowered and raised, bringing with it a quantity of sand from the bottom in a box or bucket suspended from one of the ends of the yard.

It was considered an event in the annals of Glasgow, as showing the great improvement which had been effected on the river by persevering operations, when about 1828 the first ship, the *Earl of Dalhousie*, came up to Glasgow with a cargo of sugar from the West Indies, destined, no doubt, for the sugar-refinery which then stood in Ann Street. This vessel must have taken several tides to get up, coming, as she did, partly under sail and partly horse-towed. No wonder that the early dredgers were called the "Terror of Greenock," as now here was the commodity, which formerly was transhipped and brought up by the goods steamers, *Industry* and *Trusty*, discharged a hundred yards or so from its ultimate destination.

Above the Glasgow Bridge the houses on the north side were residential, and had grass slopes extending from the outside of the roadway to the water, an iron railing dividing the grassy part from the street, something like what still exists on the south side.

At that time the city of Glasgow lay mostly on the

north side of the Clyde; on the south side was the Barony of Gorbals; Calton, Bridgeton, Anderston, and Finnieston adjoined the city proper on the east and west.

Pennant in his *Tour in Scotland*, 1772, says: "The city of Glasgow till lately was perfectly tantalized with its river; the water was shallow, the channel much too wide for the usual quantity of water that flowed down, and the navigation interrupted by twelve remarkable shoals. Spring-tides do not flow above three feet or neap-tides above one at Broomy-Law quay, close to the town, so that in dry seasons lighters are detained there for several weeks, or are prevented from arriving there, to the great detriment of the city." He then refers to his friend John Golborne of Chester, "that honest and able engineer," being called in by the city authorities; "and he entered into contract with the magistrates of Glasgow to deepen the channel to seven feet at the quay, even at neap-tides." And he adds, "before this improvement lighters of only thirty tons burden could reach the quay; at present vessels of seventy come there with ease."

Mr. Pennant proceeds down the river, and goes to "survey the machines for deepening the river; they are called ploughs, are large hollow cases, the back is of cast-iron, the two ends of wood, the other side open. These are drawn across the river by means of capstans placed on long wooden frames or flats; are drawn over empty, returned with the iron side downwards, which scoops the bottom and brings up at every return half a ton of gravel, depositing it on the bank, and thus twelve hundred tons are cleared every day. Where the river is too wide the shores are contracted by jetties." These jetties, by the

eddies around them, gradually accumulated sand, &c., and so narrowed the channel; and to increase the natural scour of the river-flow Rennie proposed to still further increase the action by joining the jetties by training walls. Telford at a later date was called in, but seems to have looked at the question more from the point of view of the tidal water being allowed to flow freely up the river, and so add to the scour in its downward course.

The condition of the Clyde has exercised the faculties of the inhabitants on its banks from an early period. Indeed, so far back as the year 1566 an attempt was made to clear away an extensive shoal or sand-bank above Dumbarton Rock, near Dumbuck. Since that time the bed of the river has had much attention turned to it, and various have been the means adopted to give it that breadth of water-way which from time to time it was thought desirable to have. Eminent authorities were called in, surveys carried out, and plans made, showing the existing condition of things. Smeaton, the "father of modern engineering," and builder of the famous Eddystone Lighthouse, reported in 1755, and he points out, to begin with, *twelve* shoals between Glasgow and Renfrew, the depths of water on some of these being 15 inches at low and 44 inches at high water. To enable vessels 70 feet long to get up to Glasgow, he proposed to get a constant depth of 4½ feet for a few miles down, by placing a dam and lock across the river. Watt, afterwards famous for his revolution in the steam-engine, made a survey in 1769 and reported on the depth of the channel. Ingenious minds were at work devising other schemes whereby the river could be made available for the passage of larger

vessels. One of these was to place large waterproof bags at the sides of the vessel, so as to float her up higher towards the surface; the inventor pointing out that a vessel requiring 10 or 15 feet of water in ordinary cases might be made to float with 5 feet or even less; he then goes into a calculation, showing the quantity of air required.

To render the river navigable above the harbour was also the subject of a design. This was to place a timber dam on the top of the weir, already referred to as existing below the Glasgow Bridge. Part of this dam was to be floating, so that when the water was low the upper or movable part would remain down upon the fixed part, and so constitute a dam, raising the water above to that extent, but when the water rose, due to floods in the river, the upper part would rise and allow the flood-water readily to flow down. One special advantage claimed in thus raising the level of the river, was that the sand and mud which is brought down during floods, would not be stopped in its downward course as is the case with a fixed dam, but would pass onwards with the flood-water when the floating part of the dam rose.

Golborne in 1768 reported that "The River Clyde is at present in a state of nature, and for want of due attention has been suffered to expand too much;" and he goes on to state: "I shall proceed on these principles of assisting nature when she cannot do her own work, by removing the stones and hard gravel from the bottom of the river where it is shallow, and by contracting the channel where it is worn too wide." Golborne, in thus "assisting nature," shows advanced views, and the result afterwards proved that his opinions were

founded on correct principles. It is interesting to find very much the same ideas expressed by the late Prof. Rankine in his *Manual of Civil Engineering*, written about one hundred years after. Speaking of improvements of river channels, he says: "The works for the improvement of the channel consist mainly of:—I. Excavations to remove islands and shoals, and widen narrow places. II. Regulating dykes, to contract wide shallows. III. Works for stopping useless branches." And further, "the object kept in view should be to obtain a channel either of nearly uniform section, or of a section gradually enlarging from above downwards, with a current that shall be sufficient to discharge flood-waters without overflowing the banks more than can be avoided, and at the same time not so rapid as to make it difficult or impossible to preserve the stability of the channel."

In the discussion of a paper on "The River Clyde," by Mr. Jas. Deas, C.E., engineer to the Clyde Trustees,[1] Mr. James Abernethy said: "Amongst the various navigable tidal rivers of Great Britain the Clyde stood prominently forward as an example of a river improved by following out what he considered a sound engineering principle, namely, that of bringing the river into a state of equilibrium by the construction of works to create a current proportionate to the size and form of the channel and the nature of its bed." Mr. Abernethy then went on to say that Smeaton, Golborne, Watt, Telford, Rennie, and Walker had acted on the principle of increasing the tidal volume and prolonging its flow upwards by dredging, and by filling up indents which tended to create eddies. The

[1] See Minutes, *Proceedings, Inst. Civil Engineers*, vol. xxxvi.

jetties with their joining training-walls and dredging had to a great extent improved the Clyde; he thought that the Clyde and Tyne were illustrations that navigable channels of tidal rivers depended on tidal ebb and flow and not upon the natural stream or floods.

Some of the special characteristics of the navigable water-way of the Clyde were given recently by Mr. Deas (meeting of the Inst. Mechanical Engineers, Edinburgh, 1887). "A hundred years ago at Glasgow there was at low water a depth of 15 inches. Now they had from 18 to 20 feet at Glasgow at low-water. One hundred years ago high-water was only noticeable at Glasgow—it came rippling up. Now they had 11 feet range of tide, and a good deal of the depth had been obtained, not by the raising of high-water, but by taking out the bottom, which was now virtually level from Port-Glasgow to Glasgow. The tide at Glasgow 100 years ago was three hours later than at Port-Glasgow. It was now only one hour later. In 1871 there took place 59 groundings between Glasgow and the sea, and the maximum draught was 21 feet 7 inches. Last year the groundings were only 16, and the maximum draught was 24 feet 9 inches."

From the experience gathered during the past one hundred years engineers may readily determine their course of action in regard to the improvement of tidal rivers; and when we see the present condition of such rivers as the Clyde and the Tyne, with their great depth of water and well-formed lines of banks, carrying the largest vessels both of the merchant and Her Majesty's navy, we are apt to forget the difficulties which beset the would-be improvers of these rivers fully a century

ago; that these difficulties were not slight is the more obvious when we consider the high engineering talent and skill which from time to time were devoted to the desired improvements. The Clyde had for its early engineering advisers, as already stated, such well-known men as Smeaton and James Watt. Later on Rennie, the designer of Waterloo Bridge on the Thames, Plymouth Breakwater, and other great works, advised the authorities in 1799; and Telford, the great bridge and road builder, was also called to give his advice in 1806. Walker and Ure at later dates gave completeness to the earlier efforts, and the charge of this important work is now placed under the care of Mr. James Deas, C.E.

Turning to the sister river, the Tyne, we find that in 1782 a survey was made by John Fryer, who, like Watt, was a mathematician. Rennie in 1813 reported on the best methods of dealing with the natural channel, such as by narrowing it at certain wide parts and widening and removing obstructions at others. Cubitt, Rendell, and Walker at later dates also contributed of their wide engineering experience, the work being finally brought to a successful issue under Ure in 1859.

It is interesting to trace in the records left the various ideas of the engineers employed to bring about the grand results obtained in both rivers. In the case of the Clyde we find that Smeaton proposed to place a lock and dam at a part of the river called the Marling Ford, which from a map of the river made by John Watt, sen., in 1734, is placed about a couple of miles above Renfrew. The lock was to be 70 feet long by 18 feet wide, and deep enough to admit of a "lighter" drawing 4½ feet of

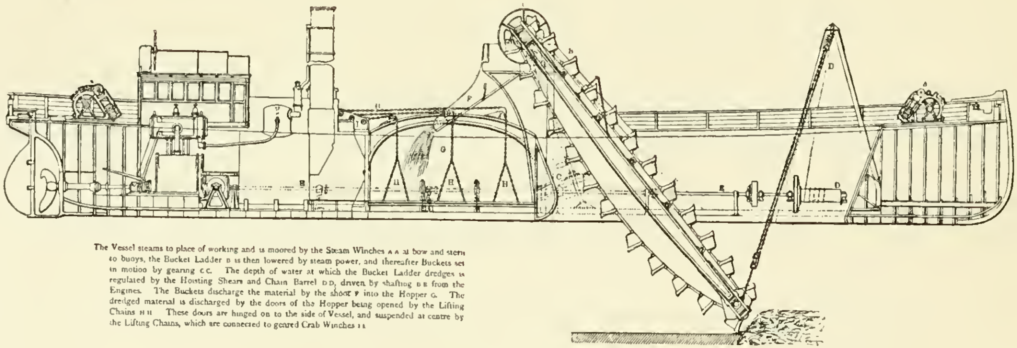
water, passing through and up to Glasgow. Nothing came of this proposal, and Golborne was called in to help the magistrates of the city in their difficulty. He proposed to contract the river by jetties, and also to dredge the channel. In 1770 an act of parliament was obtained for this purpose. The work was carried out, and by 1775 Golborne had built 117 jetties, and raised the depth of the water at the Broomielaw, so that vessels drawing 6 feet of water could come up to the quay there at high-tide. Rennie's proposal was to join the ends of the jetties by training-walls. This was afterwards done and land reclaimed from the river. Telford did not place much reliance on the jetties, as he considered the main thing was to get as much tidal water up the river as possible by shaping the bed to suit.

Turning to the Tyne, we find an additional difficulty confronting the engineers in the bar at its mouth. Thus besides the improvement of the channel of the river, the prolongation of this channel through the bar had to be attended to. Rennie in 1813 recommended improvements on the banks and channel by walls. Nothing, however, was done. Cubitt in 1837 approved of this plan, but considered that dredging should also be employed. This was carried out, but the results were not satisfactory. Walker believed that the first difficulty lay in the bar. Piers were then built out from Tynemouth and South Shields. Dredging also went on. But it was not till after 1859 that effective results were obtained through the vigorous measures resorted to by Mr. Ure, which included thorough and complete dredging. The result being that instead of a depth of water on the bar of 6

feet at low-water and 4 feet in the channel up to Newcastle, as in 1813, and as it continued very much for forty years afterwards, the condition of things in 1879 was that the depth on the bar was 22 feet at low-water, and 37 feet at high-water of springs; and at Newcastle 20 to 25 feet at low, and 35 to 40 feet at high water.

The great advantage obtained by securing an additional tidal flow has been well exemplified at the port of Dublin, where, about seventy years ago the depth of water on the bar was only about six feet, but by building the Bull Wall out towards the end of the previously built South Wall, a large water area was obtained amounting to about 2500 acres, the scour due to the ebb of which rapidly cut down into the bar, until a depth of 16 feet at low-water was obtained, or 28 feet at high-water of springs. The river channel is deepened by dredging, the dredgings being removed in hopper-barges, some of them carrying 1000 tons, and deposited outside in the sea. The dredging plant of the Clyde Navigation Trustees consists of 6 dredging machines from 40 to 75 nominal horse-power; 1 floating steam digger barge; 18 hopper-barges from 35 to 65 nominal horse-power, with a fleet of punts and boats, several diving-bells, &c. Some of the dredgers are capable of working in 30 ft. of water, and have lifted nearly 400,000 cubic yards in a single year. During the year 1887, 1,319,344 cubic yards were dredged. The total amount dredged during the last forty-three years amounts to 32,261,778 cubic yards.

The following reference to the deepening of bars appeared in the *Times*, 1885: "The Cunard Company have



The Vessel steams to place of working and is moored by the Steam Winches A A at bow and stern to buoys, the Bucket Ladder B is then lowered by steam power, and thereafter Buckets set in motion by gearing C C. The depth of water at which the Bucket Ladder dredges is regulated by the Hoisting Shears and Chain Barrel D D, driven by shafting E E from the Engines. The Buckets discharge the material by the shoot F into the Hopper G. The dredged material is discharged by the doors of the Hopper being opened by the Lifting Chains H H. These doors are hinged on to the side of Vessel, and suspended at centre by the Lifting Chains, which are connected to geared Crab Winches I I.

Hopper Dredger for Excavating and Transporting Material by Messrs. Simons & Coy., Renfrew.

now reached the limit of draught permitted by the entrance to New York. Measures, however, are being taken to dredge away or rather disperse the bar to the extent of 2 ft., by a machine called a dredging plough, which is designed to disturb the bar and disperse the sand by air force when the currents are setting seawards. Still, when this is done it will only permit vessels coming east to be fully laden instead of as at present leaving freight unshipped. The ship-owner and ship-builder can now do little more for the ease of an Atlantic voyage; they wait upon the harbour and dock authorities for permission to increase the breadth and depth, and therefore the steadiness and comfort, of their steamers."

The river Mersey is only about 56 miles in length, but at Liverpool is much wider than the Clyde at Glasgow, being a thousand yards in width between Liverpool and Birkenhead. An immense area of sand-banks exists at the mouth of the river; various channels exists through these banks, kept in equilibrium by the flow of the tide. On the bar at the mouth of the main channel the depth at low-water of spring-tides is as little as 10 feet, and at high-water 40 feet, thus giving an extreme range of 30 feet. The total water area of the Liverpool docks is about 368 acres. The total water area of the Birkenhead docks is about 164½ acres. Total, 532½ acres. See Paper in *Trans. Inst. Naval Architects*, 1887, by G. F. Lyster.

As the range of the tide in the Clyde is not so great as at Liverpool or London, there is less necessity for having docks or basins with locks or gates upon them; but to increase the quay area several basins or docks have been

made opening to the river by entrances sufficiently wide for ordinary traffic, and which are crossed by swing-bridges. The first basin so constructed is known as the Kingston Dock, and was excavated in 1867 out of the lands formerly known as the Windmill Croft; the water area covers fully 5 acres. The Queen's Dock, excavated on the old lands of Stobcross on the north side, was opened in 1882, and has a water area of 33 acres. The quays alongside have a lineal extent of 3334 yards, are fitted with hydraulic cranes and capstans, and there is a railway connection with the main lines. Considerable difficulty was experienced in excavating part of this dock, where the till or boulder-clay had been largely deposited, and which from its tough tenacious nature offered great resistance to the pick or the more powerful action of explosives.

Additional docks are being made on the south side of the river immediately opposite the Queen's Dock, the entire area of which when finished will be about 38 acres, with 3786 lineal yards of quays. Two large graving-docks have been constructed within the last few years, both in the neighbourhood of the docks in process of construction on the south side of the river. It may be sufficient to give an idea of the size of these docks if we say that the *City of Rome*, the longest steamship afloat—always excepting the *Great Eastern*, which has long had the misfortune to be out of employment—was docked in No. 1 Graving Dock a year or two ago. No. 2 Graving Dock was opened in 1886, and is close to No. 1. The two docks are very similar in design, and the following extracts from description of No. 2 Dock,

by Mr. James Deas, C.E., the engineer of these works, will give a correct idea of their character:—

"Length of floor from inside of caisson,	575 ft.	0 in.
Width at bottom, - - - - -	52 „	4 „
„ top, - - - - -	92 „	0 „
„ of entrance at bottom, -	57 „	6 „
„ „ top, - -	67 „	0 „
Depth on centre of sill at average high-water of ordinary spring-tides,	22 „	10 „

"The wing walls and apron of entrance are carried on triune concrete cylinders, 9 ft. in external and 5 ft. 9 in. internal diameter, sunk 24 ft. into the ground, and filled up with concrete, their tops being 3 ft. below the level of top of sill at centre." This system of concrete cylinders has also been successfully used by Mr. Deas in the other works of dock and quay walls from time to time in the extensions made by the Clyde Trust. "The whole body of the dock is of concrete, except the side walls of entrance, the stairs, timber slides, top altar course, and cope, which are of granite, and all the other altar courses, seventeen in number, of granolithic 14 in. on the tread and 18½ in. rise, except the bottom course, which is 30 in. average rise." "The floor of caisson chamber is a brick-in-cement invert, with granite stones and cast-iron blocks alternately for carrying the rails upon which the caisson travels." "The caisson for closing the entrance is of iron, rectangular in shape." The steam pumping machinery of No. 1 Dock is also employed for No. 2 Dock. The cost is stated as not exceeding £100,000. No. 1 Dock cost £127,500.

The principal shipping quays on each side of the Clyde extend from the Broomielaw to the entrance of the Queen's Dock. Additional wharfage exists both further down and above the Glasgow Bridge, the total length of quayage being about 6 miles.

STEAM NAVIGATION.

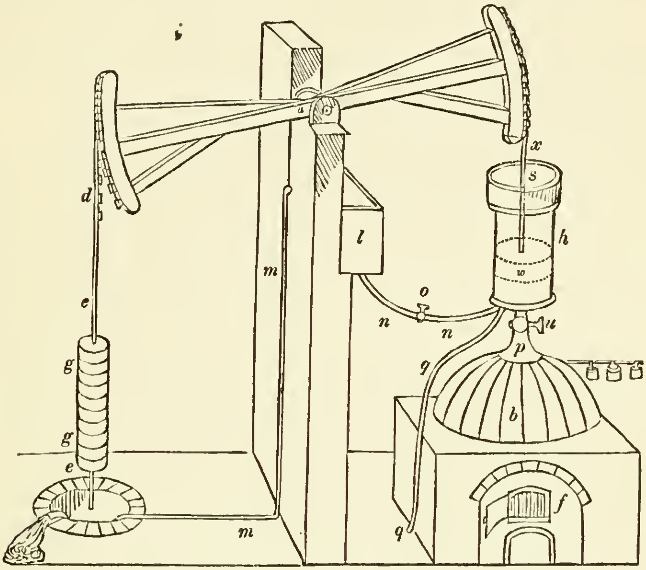
The Clyde has the honourable distinction of being the first European river on which the steamboat was used commercially. Various attempts had been made from time to time by many ingenious inventors to apply the steam-engine to propel vessels. Amongst the earliest of these is the patent of Jonathan Hulls, in 1736, for a tow-boat, having a rotatory paddle at the stern, driven by a steam apparatus placed in the boat. It is said, however, that Denis Papin, in 1707, invented a steamboat in which he ascended the river Weser. The inhabitants on the banks, resenting this innovation on their boating privileges, are said to have destroyed his vessel. Curiously enough, since history is said to repeat itself, the same sudden termination to another and like effort of applied science seems to have taken place nearer home, as tradition says that the boatmen of Loch Katrine were so indignant at the appearance of the first steamer which was placed on this beautiful sheet of water that they managed to sink her. These stories seem probable enough when we find that the feeling at coast places was so strong against the steamboats that they were not allowed to approach the quay, and it is said that a steamer lying off one of the coast

towns had her cables cut, some of the old boatmen being of the belief that she was aided by the powers of evil.

Papin, who appears to have been a very able man, turned his attention, so far back as the year 1690, to improvements in the cylinders of the rude steam appliances of his day, and it is said that he conceived the idea of moving a piston in a cylinder by the alternate action of the pressure and condensation of steam effected in the cylinder,—the great improvement of Watt, in 1764, was the condensation of the steam in a separate vessel called the condenser, whereby the loss of power due to the alternate heating and cooling of the cylinder, as in Newcomen's engine, was overcome.

An important attempt to utilize steam to propel vessels was made by Patrick Miller of Dalswinton, on Dalswinton Loch, Dumfriesshire, in the year 1788. The boat used in the experiments had a double hull, thus anticipating the twin boats afterwards tried from time to time, one now working successfully, on the English Channel. It measured 25 feet in length by 7 feet in breadth, and was fitted with two paddle-wheels, one before and the other behind the engine. It appears that Mr. Miller was endeavouring to find some means of turning paddles fitted into small boats with which he was experimenting, and a Mr. Jas. Taylor suggested the steam-engine as a propelling power. This suggestion was, however, met by the following reply from Mr. Miller: "That is a powerful agent, I allow, but will not answer my purpose, for when I wish chiefly to give aid it cannot be used. In such cases as the disastrous event which happened lately, of the wreck of a

whole fleet upon a lee-shore, off the coast of Spain, every fire on board must be extinguished, and, of course, such an engine could be of no use." Later on it was determined to try the steam-engine, and a young mechanic,



Newcomen Engine.—From Prof. Rankine's Manual of the Steam Engine.

a, Beam; *b*, boiler; *d*, pump-rod chain; *e*, pump rod; *f*, furnace; *g g*, counterpoise *h*, cylinder; *p*, steam-pipe; *u*, steam-cock; *l*, tank for condensation water; *m n*, condensation-water pipes; *o*, cock; *q*, discharge pipe from cylinder; *s*, piston rod; *w*, piston; *x*, piston-rod chain.

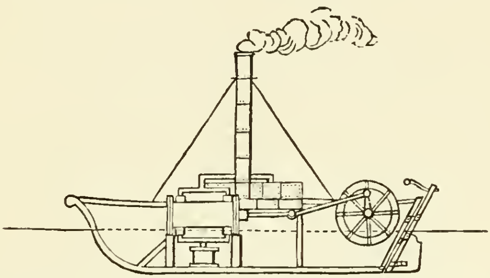
Wm. Symington, was employed to superintend its construction at Edinburgh. The result was very satisfactory, as the vessel moved at the rate of 5 miles an hour. The boat was afterwards laid up, and in 1789 Mr. Miller, with Taylor and Symington as assistants, made another

experiment, this time on the Forth and Clyde Canal near Carron, at which works the engine was made. The first trial was unsuccessful, as the paddle-wheels gave way when full power was put on. This defect was soon remedied and a successful trial made, the speed being nearly 7 miles an hour. The expense and trouble in connection with this experiment caused Mr. Miller to have the boat dismantled, although he still intended to work out his ideas on steam propulsion.

In 1801 Lord Dundas employed Symington to fit up a steamboat for trial on the canal, and in 1802 the vessel named *Charlotte Dundas* was tried on the Forth and Clyde Canal. In this vessel Symington introduced the important addition of a crank connection with the paddle-wheel, whereby a direct rotatory action was kept up. The engine was, in this way, much in advance of those previously tried, and curiously enough remained in advance of many of the after-made machinery for propelling the Clyde steamers, where, instead of the action being directly applied, as in this case, the motion of the wheels was obtained through intermediate levers and spur-wheel gearing. In reference to this, Professor Rankine, in his *Manual of the Steam Engine*, says: "The *Charlotte Dundas* had one paddle-wheel near the stern, driven by a direct-acting horizontal engine, with a connecting-rod and crank. The arrangement of her mechanism was such as would be considered creditable at the present day; and she has been justly styled by Mr. Woodcroft 'the first practical steamboat.'"

It may be mentioned that one of the first iron vessels was built at Faskine, on the Monkland Canal, a few

miles east of Glasgow. She was named the *Vulcan*, and started with passengers from Port-Dundas to Lock 16 on the 15th September, 1819. Forty-five years afterwards she was still in good condition, but doing service as a cargo boat.



Steamer Charlotte Dundas.—From Prof. Rankine's Manual of the Steam Engine; by permission.

The following verses, written by William Muir, Birdston, near Kirkintilloch, in March, 1803, on seeing the *Charlotte Dundas* pass on the canal, are interesting, as giving us a humorous glimpse into the past, enabling those of the present day who are familiar with such splendid achievements in marine architecture as are seen on our ocean highways, to appreciate to some extent the difficulties which at that time had to be overcome, and the wonder and amazement of the beholders of the early attempts at steam propulsion:—

"When first, by labour, Forth an' Clyde
Were taught o'er Scotia's hills to ride,
In a canal, deep, lang, an' wide,
    Naebody thocht
That winders, without win' or tide,
    Would e'er be wrocht.

"To gar them trow that boats would sail
Thro' fields o' corn or beds o' kail,
An' turn o'er glens their rudder's tail,
Like weathercocks,
Was doctrine that wad needed bail
Wi' common folks.

"They ca'd it nonsense, till at last
They saw boats travel east and wast,
Wi' sails an' streamers at their mast,—
Syne, without jeering,
They were convinced the blustering blast
Was worth the hearing.

"For mony a year, wi' little clatter,
An' naething said about the matter,
The horses haul'd them through the water,
Frae Forth tae Clyde;
Or the reverse, wi' weary splatter,
An' sweaty side.

"But little think we what's in noddles,
Whar Science sits an' grapes and guddles,
Syne darklins forth frae drumly puddles,
Brings forth to view
That the weak penetration fuddles
O' me an' you."

The author then refers to the new lighter as being driven

"Wi' something that the learned ca' steam;"

and adds:—

"By it she through the water plashes,
An' out the stream behint her dashes
At sic a rate, baith frogs and fishes
Are forced to scud,
Like ducks and drakes amang the rashes,
To shun the mud."

And after this vivid description of the rapid movement of the novelty, he proceeds to speculate on what he has seen:—

"Can e'er, thought I, a flame o' reek,
Or boiling water's cauldron smeek,
Tho' it war keepit for a week,
Perform sic wonders,
As quite surprises maist the folks
O' gazin' hunders?"

And finally finishes in a philosophic and prophetic vein:—

"But facts, we canna well dispute them,
Altho' we little ken about them;
When prejudice inclines to doubt them
Wi' a' her might
Plain demonstration deep can root them,
An' set us right.

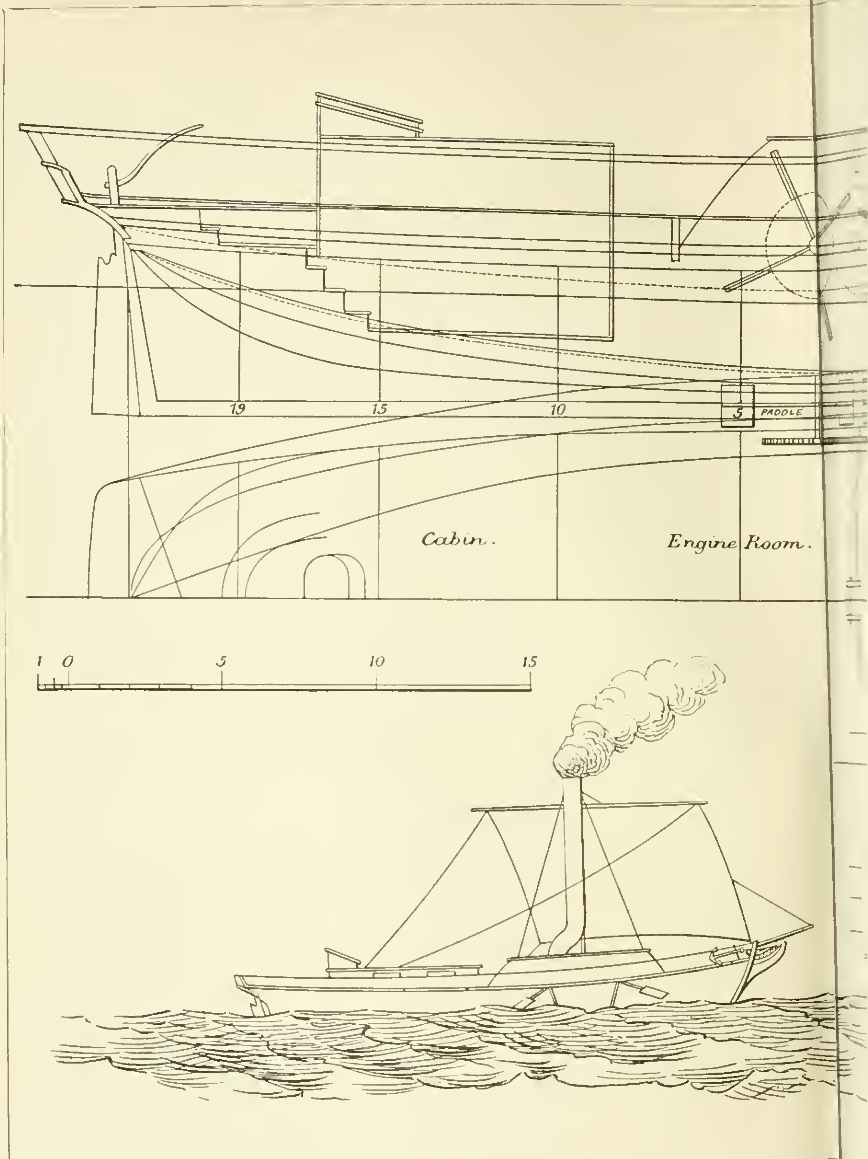
"Or lang gae now, wi' whirligigs
An' steam engines we'll plough our rigs,
An' gang about on easy legs
Wi' nought to pain us,
But flit in tethers needless nags
That used to hain us."

Returning, however, to the Clyde, we come upon a notable period in our history, as in the year 1811 Henry Bell arranged with John Wood, of Port-Glasgow, to build a vessel for him, to be fitted with an engine by John Robertson of Glasgow. This vessel was launched in June, 1812, with steam up, and made her first trip to Helensburgh. She was named the *Comet,* after a famous meteor which had shone across the heavens for some time previous.[1] This vessel, the precursor of the

[1] See reference to this meteor at p. 113.

long line which followed, year by year, in growing numbers, was fitly named. She was to many as much an apparition as the strange and uncanny visitor of the skies, and, as with it, her train of successors has spread, like a tail, far out in ever-widening sweep.

The *Comet* was a wooden boat, 42 feet long, 11 feet broad, and 5 feet 6 inches deep. She had the usual long funnel of the early steamers, and it occasionally did duty as a mast, a large square sail being hoisted on it when the wind was favourable. The engine was made by John Robertson, and was a condensing one of 3 horse-power, the diameter of the cylinder being 11 inches and the stroke 16 inches. The crank worked below the cylinder, and the engine shaft was of cast-iron, square in section, and measured 3½ inches on the side. A fly-wheel was added to equalize the motion. The vessel was originally fitted with two pair of paddle-wheels, 7 feet in diameter, having spur-wheels of 3½ feet diameter attached, so that, by means of another spur-wheel of the same diameter, placed between these, and gearing into them, each pair of paddles was rotated at the same speed. This arrangement was obviously very inefficient, as the one pair of paddle-wheels worked in the wash of the other pair, besides the loss of power due to working through the toothed wheels. It is said that Robertson, the engineer, tried to dissuade Bell from arranging his wheels in this manner, but the latter stuck firm to his idea, and the boat was tried with them, but proved a failure. The double wheels were then removed, and Robertson made another engine of about 4-horse power, having a cylinder of 12½ inches diameter. The workshop where the engine of



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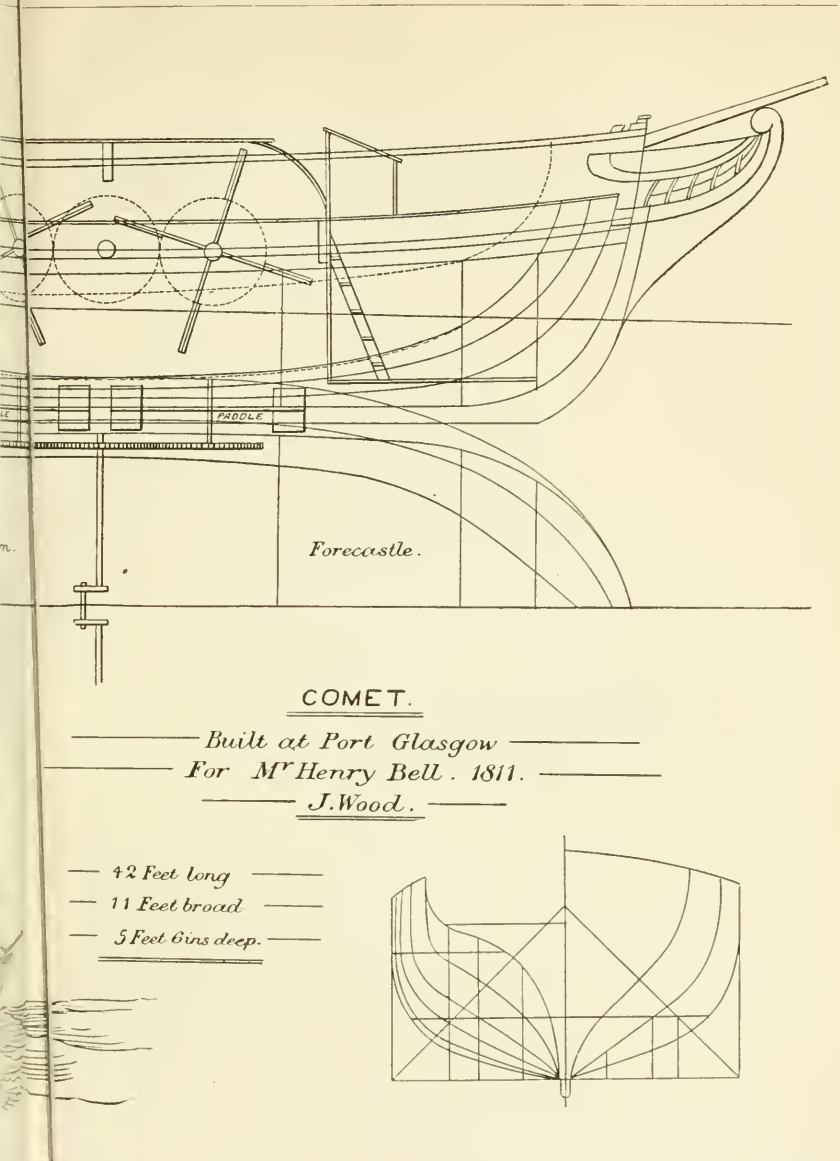
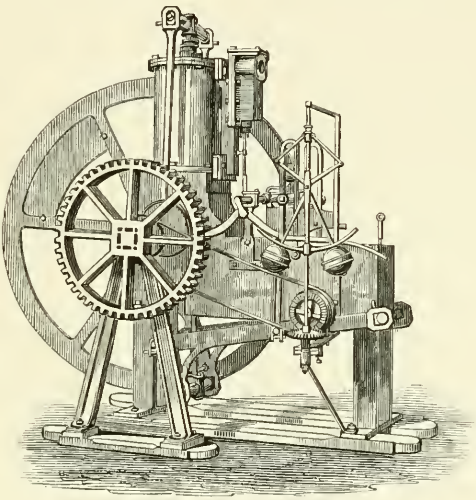
From a photograph from the original, ki



...FT F THE COMET BY JOHN WOOD.

...ndly ...pplied by Henry M. Napier, Esq.

this famous steamer was made was situated in Dempster Street, a small street off North Frederick Street, in the north part of Glasgow. The original model of the *Comet* is in the possession of Messrs. John Reid & Co., shipbuilders, Port-Glasgow, and shows the double set of



Engine of the Comet Steamboat.

paddle-wheels as originally proposed and tried. See plate, which is a facsimile from a photograph of the original draft of this vessel, kindly supplied by Henry M. Napier, Esq. The drawing shows the vessel in both plan and section, with the first-tried arrangement of the double paddle-wheel on each side, also the spur-wheel gearing connecting the engine with the paddles.

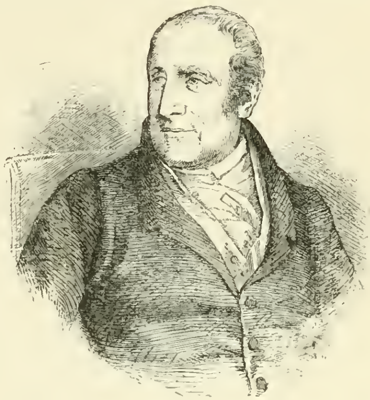
The navigation of the river had up till this time been managed by boats, which, with the combined exertions of

sail and oars, made the passage up and down the river at more or less regular intervals, as the time of the passage depended much upon wind and tide. Thus Pennant, visiting the Clyde in 1772, tells us that after passing Dumbarton, on his way to Greenock, they had "a long contest with a violent adverse wind and very turbulent water."

Bell appears early to have turned his attention to the use of the paddle with hand power, some attempts having been also made in this direction by a Mr. Rennie of Greenock. As in later trials of this method of propulsion, the labour was found greater than that required with the oar. It might, however, be supposed that, by the use of ball-bearings, which have so much conduced to the success of the modern velocipede, the resistance due to the friction of the shaft of a paddle-wheel open pleasure-boat might be greatly reduced. It is said that Brunel fitted a collar to the rudder-post of the *Great Eastern*, which, resting on cannon balls, became really an early form of ball-bearing.

The boiler of the *Comet* was made by David Napier, a name to be afterwards widely associated with the progress of steam shipping on the Clyde. The following is a copy of Bell's advertisement of his new boat: "The Steamboat *Comet*, between Glasgow, Greenock, and Helensburgh, for passengers only.—The Subscriber, having at much expense fitted up a handsome vessel to ply upon the river Clyde from Glasgow, to sail by the power of air, wind, and steam. He intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about mid-day, or such an hour thereafter as may answer from the state of the tide; and to leave

Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide. The elegance, comfort, safety, and speed of this vessel require only to be seen to meet the approbation of the public; and the proprietor is determined to do everything in his power to merit general support. The terms are for the present fixed at 4*s.* for the best cabin and 3*s.* for the second, but beyond these rates nothing is to be allowed to servants or any person employed about the vessel.



Henry Bell.

"The subscriber continues his establishment at Helensburgh Baths, the same as for years passed, and a vessel will be in readiness to convey passengers by the *Comet* from Greenock to Helensburgh.

"Henry Bell."

"Helensburgh Baths, 5th August, 1812."

This advertisement of Bell's in which the power of wind is referred to, brings up forcibly the condition of the early navigation of the Clyde when the passenger communication with Greenock and the other lower ports of the river was carried on by means of what were termed Fly-Boats,[1] which made their passage to and fro

[1] The term Fly seems to have come from the coaches on the roads, as diligences, coaches, and flys are advertised in the first Glasgow Directory.

by means of the power of wind and oars, occasionally, it is said, being helped by horse power. The incidents in such journeys must have been frequently of a humorous description, as the following graphic sketch which appeared some years ago in the *Glasgow Herald* will show: "The passage to Greenock in favourable circumstances was accomplished in about ten or twelve hours; as much depended on the flow of the tidal wave, not unfrequently the passage was interrupted for a night at Bowling. It was surmised that the *flies* were intercepted there by a net or web in the shape of a tavern. The passengers had frequently to remain in their ark, or get quarters in the 'public' until the morning. A story was told and vouched that when a 'fly' had been thus arrested for the night, and the crew were called in early and dusky morn to avail themselves of the favourable tide, the two boatmen, who had been meantime indulging in strong drink, set to work with their oars. With the dawn the passengers had a dreamy notion that they were making little or no progress as the outline of the castellated rock, still phantom-like, appeared in the mist. Calling the attention of the rowers to their apprehensions, the fact was painfully realized by the following colloquy between the ancient mariners: 'Tonalt, did you lift t' anchor?' and the discouraging reply, 'Na, Tougal, not me, but 'twas your duty.'"

From the *Memorials of James Watt* we learn that these Flyboats were built by W. Nicol, a Greenock boatbuilder, and that they were a great improvement on the smaller packet boats. They measured about 28 ft. in length by 8 ft. beam, and were wherry-rigged. The passengers were protected from the weather by a cover over the

after part of the boat. A projecting platform ran round the deck outside of this cabin for the crew to pass and repass, and on fine weather by favour of the commanding officer some of the passengers were allowed to sit upon the roof with their feet on the passage way. The boats generally left Greenock with the flood-tide, and if the wind was also favourable Glasgow might be arrived at in from four to five hours. As late as 1820–1830 fly-boats without sails were used; these were simply large stout open boats, which were rowed by four men. They plied to Greenock from the foot of a long flight of stairs at the Broomielaw. About that time the passage to Greenock by the steamers took sometimes three hours, and the cost was 5*s.* in the cabin and 2*s.* 6*d.* in the steerage. A wherry sailed from Greenock to Helensburgh and the Gareloch in *opposition* to the steamers.

To facilitate this traffic there was a towing-path down as far as Renfrew, and it is interesting to read in Cleland's *Annals of Glasgow* under "Abstract of Regulations for Steam Boats and other Vessels."—"That none of the said Steamboats shall cross the tracking or towing lines of the vessels plying on the river where there is room to pass on the off side, under the penalty of £5 for each offence." And further "That none of the said Steamboats shall ply in the twilight or in the dark without having lights ahead fitted up properly." This regulation does not intimate the colour of the lights, or if they were to be fitted to the paddle-boxes; and it was no doubt at a later date that the well-known red and green paddle-box lights were introduced, which, on first sight, frightened some of the boatmen who happened to be out on

the river during a heavy spate, one of them declaring that an apothecaries' shop had been carried away and was drifting down on them.[1]

Even after the introduction of the steamboats the shallow condition of the Clyde at low water, together with the numerous sandbanks, made the navigation difficult and somewhat uncertain, as the boats frequently got aground and had to lie till the tide rose, the passengers sometimes assisting in getting a start by running from side to side to loosen the keel out of the sand. Besides the use of coloured lights for the more complete guidance of vessels meeting or crossing each other's path, the position and method of fixing the lamps are now specified. Thus a steamship shall carry on the front of the foremast at a height of not less than twenty feet a bright white light, on the starboard side a green light, and on the port side a red light. A sailing vessel shall carry the red and green side-lights only. The rules for the mariner's guidance have been humorously put into rhyme by Thomas Gray, C.B., secretary to the Board of Trade, thus:

TWO STEAMSHIPS MEETING.

"When all three lights I see ahead,
I port my helm and show my Red.

TWO STEAMSHIPS PASSING.

Green to Green, or Red to Red—
Perfect safety—go ahead!

[1] Lights now vary according to the craft which carry them; the red and green side-lights carried by both steamers and sailing vessels were ordered by the Admiralty in 1847, and the Merchant Shipping Act of 1862 compelled the fixing of the red and green lights in sailing ships, as in these vessels they had only previous to that date been required to be shown.

Very safe and good advice is given in the last stanza:

> "Both in safety and in doubt,
> I always keep a good look-out;
> In danger, with no room to turn,
> I ease her! Stop her! Go astern!"

The connection with places further down the river was accomplished by the steamboats carrying the passengers to Greenock, who then went by sailing packets to their destination. It is recorded by a traveller in 1815 that he sailed in the *Comet* from Glasgow for Greenock, leaving in the morning and arriving at Greenock after a seven hours' passage, three hours of which had, however, been spent lying on a sand-bank at Erskine. At Greenock he went on board the *Rosa* packet and landed in Rothesay the same day, much to the surprise of the residenters there, as the passage was an extraordinarily fast one.

The *Comet* was followed by the *Elizabeth*, of 33 tons, built in 1812–13, by John Wood. She measured 58 ft. long over all, 51 ft. keel, 12 ft. beam, and was 5 ft. deep. The engine was made by James Cook of Tradeston, Glasgow, and was of 10 H.P. The following copy of an advertisement in reference to this steamer is given in a work on *Steam and Steam Navigation*, by J. Scott Russell, and is interesting as giving us a good deal of insight into the appearance and management of the early Clyde steamers: "The *Elizabeth* was started for passengers on the 9th of March, 1813, and has continued to run from Glasgow to Greenock daily, leaving Glasgow in the morning and returning the same evening. The passage, which is twenty-seven miles, has been made, with a

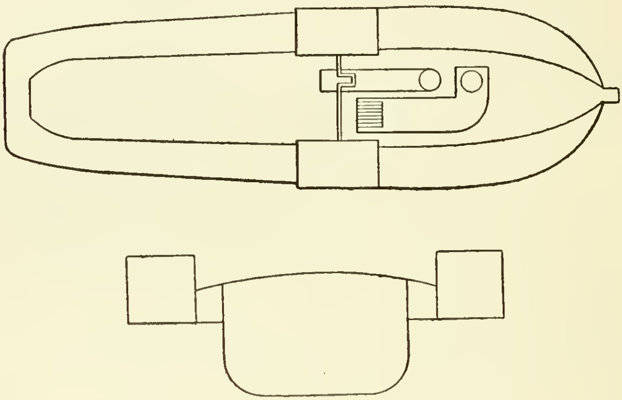
hundred passengers on board, in something less than four hours, and in favourable circumstances in two hours and three-quarters. The *Elizabeth* has sailed eighty-one miles in one day, at an average of *nine miles an hour.* The *Elizabeth* measures aloft fifty-eight feet; the best cabin is twenty-one feet long, eleven feet three at mid-ships, and nine feet four inches aft, seated all round, and covered with handsome carpeting; a sofa, clothed with marone, is placed at one end of the cabin, and gives the whole a warm and cheerful appearance. There are twelve small windows, each finished with marone curtains, with tassels, fringes, and velvet cornices, ornamented with gilt ornaments, having altogether a very rich effect. Above the sofa there is a large mirror suspended, and at each side book-shelves are placed, containing a collection of the best authors, for the amusement and edification of those who may avail themselves of them during the passage—other amusements are likewise to be had on board. The engine stands amidships, and requires a considerable space in length, and all the breadth of the vessel. The forecastle, which is rather small, is about eleven feet six by nine feet six inches, not quite so comfortable as the after one, but well calculated for a cold day, and by no means disagreeable on a warm one; all the windows in both the cabins are made in such a way as to shift up and down like those of a coach, admitting a very free circulation of fresh air. From the height of the roofs of both cabins, which are about seven feet four inches, they will be extremely pleasant and healthful in the summer months for those who may favour the boat in parties of pleasure. Already the public advantages of this mode of con-

veyance have been generally acknowledged; indeed, it may without exaggeration be said that the intercourse through the medium of the steamboats between Glasgow and Greenock has, comparatively speaking, brought these places ten or twelve miles nearer to each other. In most cases the passages are made in the same time as by the coaches; and they have been, in numerous instances, done with greater rapidity. In comparing the comfortableness of these conveyances, the preference will be given decidedly to the steamboat. Besides all this, a great saving in point of expense is produced; the fare in the best cabin being only four shillings, and in the inferior one two shillings and sixpence; whereas the inside of a coach costs not less than twelve shillings, and the outside eight shillings."

John Robertson.—From a photograph.

The *Clyde*, 69 tons, was also built by John Wood. She was 76 ft. long over all, 72 ft. keel, by 14 ft. beam, and depth of hold of 7½ ft. The engine was made by John Robertson; the cylinder was 22 in. diameter, with a 2-foot stroke, and of 14 H.P. The speed attained was six miles per hour.

The *Glasgow*, 74 tons, was built by John Wood, and was 72 ft. long by 15 ft. beam. The engine was a side-lever one, of 16 H.P., with a cylinder 20 in. diameter, stroke 2 ft., and was made by James Cook. This vessel ran to Largs and Millport, and must have been the first boat on this station. She could run from Glasgow to Greenock with the tide in two hours and ten minutes. The form



of these early boats is shown by the annexed plan and section.

In 1814, six steamers appear to have been built—viz. the *Industry*, *Trusty*, *Princess Charlotte*, *Prince of Orange*, *Marjery*, and *Argyle*. The *Industry*, still existing, was built, it is said, by Fyfe at Fairlie in 1814, her builders being afterwards celebrated for their racing yachts; a reputation which the firm, still flourishing, maintains. Her dimensions are as follows: Length, 68 ft.; breadth, 17 ft.; depth, 8 ft.; gross tonnage, 69; register,

42; one cylinder, 16 in. in diameter. She had at first a copper boiler, not an uncommon arrangement in those early days, of low pressure; but it was afterwards replaced by an iron one. The original engine was also replaced about 1826 by the one now on board. One special feature of interest, which can still be inspected, is the spur-wheel gearing to connect the engine with the paddle-shaft.[1] From the grinding sound caused by the spur-wheels she was known at Greenock as the "Coffee-mill." The original engine was by Thomson, of Tradeston, and the second engine by Caird, of Greenock. The paddle-wheels are 11 ft. diameter, with floats 2 ft. 9 in. long, ten on each wheel; stroke of engine, 2 ft.; diameter of shaft, $5\frac{1}{2}$ in.; spur-wheels, 2 ft. and $1\frac{1}{2}$ ft. in diameter. The *Industry* was the *seventh* steamer on the Clyde, and must now be the oldest steamer in existence. She plied between Glasgow and Greenock, principally as a luggage boat, but occasionally ventured down the firth as far as Campbeltown.

Strangely enough, at the present time the Clyde contains two of the greatest curiosities in marine architecture, viz. the oldest steamer extant—the *Industry*—and the largest vessel in the world—the *Great Eastern*, which for some time has been lying at the "Tail of the Bank," off Greenock. The dimensions of the latter, as given in the advertisement of bill of sale, is: Length, 679·6 ft.; breadth, 82·8 ft.; depth, 60 ft. Tons B.M., 22,927; tons gross, 18,915; tons nett register, 13,344.

[1] This engine has now been removed for the purpose of being preserved as an illustration of the early forms of engines, and is now placed near the Kelvingrove Museum. See cut p. 211.

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Screw engines, 1,600 H.P. nominal; paddle engines, 1,000 H.P. nominal. On comparing these dimensions with those of the *Industry*, we find that the *Great Eastern* is ten times longer, about five times broader, and seven and a half times deeper. The tonnage is about three hundred times greater.

It may be interesting to note that the combined length of these seven precursors of steam traffic on the Clyde was little over 400 ft., so that, if placed end to end, they could all have been carried by such a vessel as the Anchor Line steamer *Furnessia*, now sailing from the Clyde, which measures 445 ft. long.

The *Trusty* was a boat like the *Industry*, and is said to have been the first steamer built at Dumbarton; the builder being Wm. Denny. She was 68 ft. long, with a breadth of 17 ft. 6 in., having a geared side-lever engine of 10 H.P. made by George Dobbie, Tradeston. Like the *Industry*, she got a new engine of greater power at a later date. This boat appears to have sunk in the river after a collision, but was afterwards raised and converted into a schooner, and wrecked in 1854 off Loch Ryan.

The *Princess Charlotte* and *Prince of Orange* were built by Mr. Munn of Greenock, and engined by Boulton & Watt.

The *Marjery* was built at Dumbarton by William Denny, and engined by James Cook, with a single side-lever engine of 10 H.P. Her dimensions were 63 ft. long by 12 ft. beam. This vessel was sent to the Thames about 1815. When the *Marjery* sailed past the Nore, at which part of the British fleet was lying, she was closely scrutinized by the old salts on board; one of them, who

belonged to Dumbarton, gave her a cheer, adding, "Well done, Dumbarton!"

The *Argyle*, 78 tons, was built at Port-Glasgow, and engined by James Cook, with a single side-lever engine of 14 H.P. She was a similar vessel to the *Albion*, and appears to have gone to the Thames in 1815.

In 1815 other six steamers appear to have been added, viz. the *Waterloo*, *Argyle* No. 2, *Greenock*, *Caledonia*, *Dumbarton Castle*, and *Britannia*.

The *Waterloo*, 90 tons, was built and launched after the celebrated battle was fought, and was similar to the *Argyle*. She plied on the Helensburgh station. The engines were by James Cook, and were of 20 H.P.

Among the songs which appeared from time to time in reference to the early boats, one refers to the *Waterloo* as follows:

"And now amid the reign of peace
Arts guiding stream we ply,
That makes our wheels, like whirling reels,
O'er yielding water fly.
As our heroes drove their foes that strove
Against the bonnets blue,
On every side the waves divide
Before the *Waterloo*."

The *Greenock*, 62 tons 10 H.P., appears to have been built by Archibald M'Lauchlan at Dumbarton. The *Caledonia*, 102 tons, was built by Messrs. Wood, Port-Glasgow. She measured 95 ft. 6 in. long by 15 ft. beam; draft 4½ ft. to 5 ft., and had two engines of 16 H.P. each, made by the Greenhead Foundry Co. This vessel went in 1816 to the Thames, and was afterwards placed on the

Rhine. The *Dumbarton Castle,* 81 tons 32 H.P. (two of 16 H.P. each), built by Archibald M'Lauchlan, Dumbarton, and engined by Duncan M'Arthur & Co., Camlachie, was the first steamer to make a trip to Rothesay, and the event was marked by the presentation of a handsome punch-bowl to the captain, James Johnston. This vessel appears to have been wrecked in the Clyde in 1829. The *Britannia,* 109 tons, 32 H.P., with a draft of 4 ft. 6 in., measured about 80 ft. long by 16 ft. beam. Her engines were made by James Cook, and consisted of a pair of beam-engines and spur-wheels to raise the power to the paddle-shaft, similar to those of the second *Waterloo* (see cut p. 183). The cylinders were 20 in. diameter, with 2 ft. 6 in. stroke. This vessel plied to Campbeltown and made a trip to Londonderry, thereby opening up the trade with the latter port. She appears to have been wrecked off Donaghadee in 1829.

The following is a copy of an advertisement appearing in the *Glasgow Herald* of June, 1815:—"The proprietors of the *Britannia* steamboat beg leave to inform the public that she, according to advertisement, performed her voyage to Largs, Rothesay, and Campbeltown, and returned in such a short time, and gave so great satisfaction, that, owing to an agreement with the public of Campbeltown, they will be under the necessity of abandoning the voyage to Inveraray, as advertised for to-morrow, but will upon Monday first, at ten o'clock, sail for Greenock, Gourock, Rothesay, and Campbeltown, and return on Wednesday. As the voyage is far, the passengers will be accommodated with refreshments, suitable and agreeable for them."

The *Britannia* appears to have had a beam-engine. The *Industry* engine is of the side-lever type; very much like a beam-engine inverted. Beam-engines are still used in America to a large extent; one of the largest examples of these being the engine of the *Pilgrim*, built in 1882, and now plying on the Fall River route by Long Island Sound, between New York and Boston. These engines have not found favour on the Clyde, but occasionally boats fitted with them for the China river service may be seen at the works of Messrs. A. & J. Inglis. About the last large mail paddle-steamer to be fitted with the side-lever engine was the *Persia*, of the Cunard Co., engined by Messrs. R. Napier, Glasgow. Another existing example of the side lever can still be seen at Dumbarton, and from its position can be readily inspected. There, the engine of the *Leven*, the first marine engine made by Robert Napier in 1824, has been erected on a pedestal at the foot of the great rock which has for so long silently looked down on the productions of the toiling hands and inventive brains of the workers of the Clyde.

In 1816 we have further additions, viz. the *Neptune, Albion, Rothesay Castle, Lord Nelson, Lady of the Lake,* and *Duke of Wellington.* This latter vessel appears to have been built by William Denny in 1817, but was a few years afterwards lengthened and named the *Highland Chieftain,* running to the Highlands till about 1838. Of these the *Albion,* 92 tons, was built by J. Wood, and measured about 70 ft. by 13 ft. beam, with draft of 4 ft. The engine (side-lever) of 20 H.P. was by James Cook, the cylinder being 22 in. diameter, with a 2-ft.

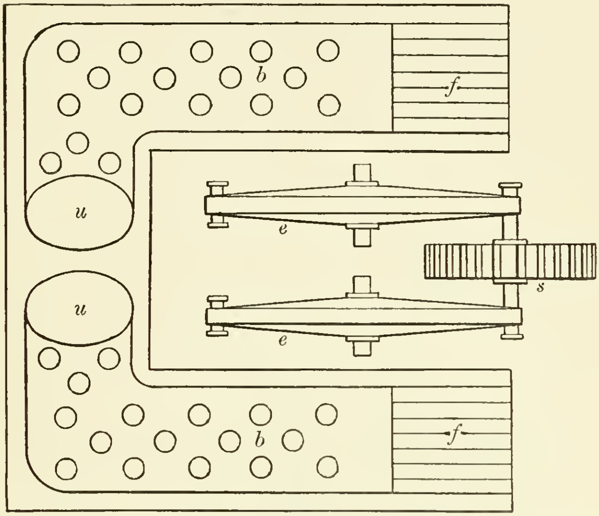
stroke. She plied to Largs. The cost of this vessel is stated as—

Hull, ...	£1,000
Engines, ...	1,600
Fittings, ...	850
	£3,450

The *Lady of the Lake*, engined by James Cook with a single side-lever engine, appears to have been transferred to the Firth of Forth, and after plying there was sent to the Elbe, but was afterwards brought back. In 1817 only two boats appear to have been added, viz. the *Marion* and the *Defiance*. Of these the *Marion* appears to have been the first steamer on Loch Lomond, where she plied in 1820 in connection with the *Post Boy* steamer from Glasgow. The year 1818 brought several additions, viz. the *Rob Roy, Marquis of Bute, Woodford, Active,* and *Despatch*. The *Rob Roy* is the most interesting, as she was the first steamer to ply to Belfast. She was 90 tons and of 30 H.P., with a draft of 7 ft., and was built by William Denny, at Dumbarton, engined with a single side-lever engine by David Napier, and was latterly transferred to the Dover and Calais service. Previous to starting this steamer it is said that Mr. Napier crossed to Belfast during a storm in a sailing vessel, and watching the effect of the waves was convinced steam could be utilized to overcome them. He then by means of experiments on model boats determined to give his proposed steamer a sharper entrance at the bow than was at that time common for the river steamers.

In 1819 the second *Waterloo* was built by Scott of Greenock, and was the longest steamer afloat at that time,

measuring about 120 feet long by 22 feet beam. She had two beam-engines with 30-inch cylinders and 3 feet stroke,

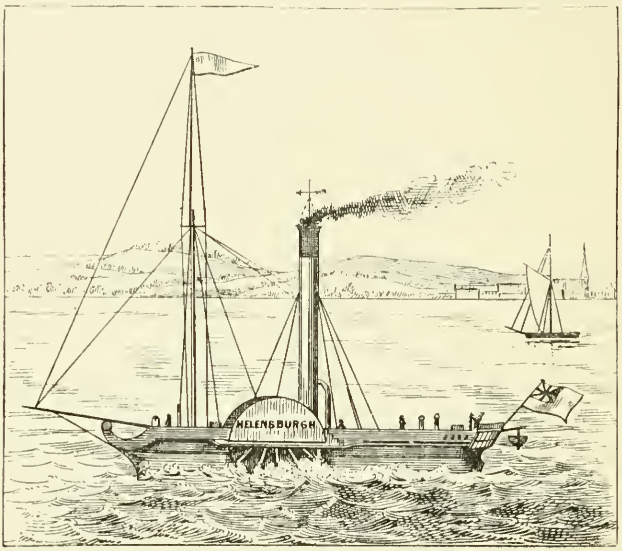


Plan of engines and boilers of the second Waterloo.
bb, boilers; *ee*, beam-engines; *s*, spur-wheel to connect engines with paddle-shaft; *ff*, furnaces; *uu*, uptakes to chimney.

with spur-wheels to connect with the paddle-shaft. See annexed cut.

In 1819 Mr. David Napier had the *Talbot* built for him by Messrs. Wood. She was 150 tons, and had two of Mr. Napier's engines of 30 H.P. each. The *Talbot* plied between Holyhead and Dublin, and appears to have been a very complete and efficient vessel. Another vessel, the *Ivanhoe*, was added to this route. She was 170 tons burthen, built by Scott of Greenock, and engined by Mr. D. Napier with engines of 60 H.P. In the same year

Mr. D. Napier established the first line of steamers between Glasgow and Liverpool, the *Robert Bruce* of 150 tons and 60 H.P. being the first to start. She was built by Messrs. Wood and engined by Mr. D. Napier. Two others were added, viz. the *Superb*, in 1820, of 240 tons and 70 H.P., and the *Eclipse*, in 1821, of 240 tons and 60 H.P. The former was built by Scott, and the latter by



Steamer Helensburgh, built by William Denny at Dumbarton about the year 1826. —From an engraving kindly supplied by Messrs. Denny.

Steele of Greenock, the engines in both cases being by Mr. D. Napier.

We may now look at one or two pictures of the early boats, and their successors of the present day. Compare

the *Superb* of 1820, and the *Etruria*, one of the largest and most powerful vessels now on the Atlantic service. The Steamboat Companion for 1820 tells us that "The *Superb*, is at this moment the finest, largest, and most powerful steam vessel in Britain. She registers 241 tons, and is impelled by two very fine engines of 36 H. P. each, to which copper boilers are attached. The average duration of the passage from the Clyde to Liverpool does not exceed thirty hours; fare, £2, 15*s*." Contrast this with what the *Times* for 1885 says:

"The *Etruria* is a sister ship to the *Umbria*, both built by John Elder & Co., of Fairfield, Govan, the largest, most finished, and fastest vessels in the Atlantic service. She is built entirely of steel, and is divided into ten water-tight compartments. She is 520 ft. long by 57 ft. 3 in. broad, and 41 ft. deep. The coming season will be an interesting one to the Atlantic traveller and to those who watch the performance of the vessels. The list is filled up for the present. There is nothing on the stocks and nothing projected to compete with what is on the water, and the public interest will centre in nine vessels, constructed within the last eight years, as follows:—

Name.	Builder.	Length. ft. in.	Breadth. ft. in.	Depth. ft. in.
Arizona................	Elder	452 2	45 4	35 7
Alaska	Elder	500	50	38
Servia	Thomson	515	52 1	37
City of Rome........	Barrow	560 2	52 3	37
Oregon	Elder	500	54	39 9
Aurania................	Thomson	470	57 2	37 2
America................	Thomson	441 8	51 2	36
Umbria................	Elder	520	57 3	41
Etruria	Elder	520	57 3	41

"The *Etruria* is fitted to accommodate 720 first-class passengers. Several of the state-rooms are fitted *en suite* for family use, and every advantage has been taken of the breadth of the vessel to afford variety and greater space in the accommodation. The saloon will seat 280 people at dinner, and as the electric lamps are fixed high up near the ceiling by slender pendants the view is unobstructed throughout the chamber. The panelling of the saloon is all in light wainscot oak, with a dark walnut sideboard at the service end and a bookcase at the other. Above, in the form of a sort of gallery, is a music-room; and on the same upper deck are a number of superior state-rooms in the middle of the ship. Above these, and running for 300 feet in length throughout the entire breadth of the ship, is a promenade deck. Here is the captain's room and a large saloon, exclusively set apart for ladies, sumptuously upholstered in green velvet and panelled in maple. Below, on the main deck, on a level with the saloon, is a boudoir, which forms a vestibule to the baths and lavatories set apart exclusively for ladies. Altogether there are 13 marble baths, fitted with steam and shower apparatus; and lavatory accommodation is dispersed throughout the ship. On the main lower decks are placed the major portion of the state-rooms. Each of them is provided with a hot-water heating apparatus, an electric light, and a life-saving cork jacket for each berth. The smoking-room, which is unusually large, is fitted with red leather benches, and is panelled in maple and oak. It is placed on the upper deck. The electric light is produced by four of Siemens's machines, each with its own three-cylinder engine. Three of them are suffi-

cient to maintain the whole 850 lamps of the ship, so that one is always in reserve, and oil lamps are entirely dispensed with. The passages, the engine-room, and boiler-house are lighted day and night, and some of the lights of the saloon are also maintained during the night. The engines are marvels of construction, and are unequalled, except by those of the *Umbria*, for strength, power, and simplicity. With good coals they are capable of indicating upwards of 14,000 horse-power, with nine boilers, but the speed attained by the *Etruria* has been secured by some thousand horse-power less than the *maximum*. The boilers are fired by 72 of Fox's corrugated furnaces. They work at a pressure of 100 lbs., which was maintained during the cruise with a total absence of smoke, even with inferior coals."

In speaking of the progress of steam navigation, Dr. Cleland says, "The success of steamboats on the Clyde induced some gentlemen in Dublin, to order two vessels to be made to ply as packets in the channel between Dublin and Holyhead, with a view of ultimately carrying the mails. They were built by Mr. James Munn, Greenock, have engines of twenty horse-power, made by Mr. James Cook, Tradestown, Glasgow, and are named *Britannia* and *Hibernia*. Mr Cook, whose eminent abilities as an engineer, have enabled him to make numerous improvements on machinery, has been very successful in constructing the paddles of these packets, so that one man can easily raise them from five to six feet out of the water, while the engine is at work, in the event of a heavy gale making that measure necessary." The author is indebted to

Mr. Robert Cook, a nephew of the Mr. Cook referred to, for much personal information of the sizes, powers, and general appearance of these early steamers.

We have clearly in the *Superb* reached a point, eight years later only than the launching of the *Comet*, when steam navigation on our coast may be considered completely and efficiently established. Certainly the time stated as taken on the voyage to Liverpool is long, but it took some years and many improvements in both vessels and machinery to reduce it to 18 hours from Greenock by the *Unicorn* in 1837, and in 1841 to 16½ hours by the *Princess Royal*. The Liverpool steamers about 1837, the *Unicorn* and *Actæon*, appear to have been very handsomely furnished, and even carried a chaplain with them who conducted divine service on Sunday. The chaplain had a special room to himself with a brass plate marked "Chaplain's Room." Notwithstanding all these advantages it was still considered a serious event to make the Liverpool journey, some travellers making their "will" and taking a special farewell of their friends ere they started.

RIVER TRAFFIC.

The traffic on the Clyde gradually increased, and new ports of call were established, at first only accessible to the passengers by ferry-boats, but soon facilities in the way of stone and wooden piers were afforded. Primitive fashions existed where no pier had yet thrown its wooden or iron piles out across the sandy shore, and where at low tide, when the ferry-boat stuck on the

sand, the ferrymen carried the passengers ashore on their backs. In regard to customs it is curious how the position from which we view certain matters affects our wonderment. Thus, the well-known practice of the quay porters on the Clyde in pointing their fingers at the passengers on board steamers arriving at the quays is little noticed by regular coasters. To strangers however it has an air of comicality; yet in a description by a Scotchman of a visit to London about fifty years ago, he says that the signal by the conductors of the street omnibuses to attract the prospective passenger's attention is pointing with the finger.

Boats had all their peculiar characteristics, especially well known to the boys who had gone "doon the water" for the holidays. Green-painted boats ran to Helensburgh, of regal and imperial designations such as *Sovereign, Queen, Emperor.* Dumbarton boats for the Vale of Leven were neat little crafts, with blue paddle-boxes and broad white strips on their black funnels. The Rothesay boats, calling at Dunoon, Kirn, &c., belonged to the Castle Company, and had quarter-deck, two masts, and a tall funnel, with the well-known white strip. The *Cardiff, Craignish,* and *Dunrobin Castles* were famous in their day, the latter with her powerful steeple engine, fast but rather crank. There were Largs and Millport boats, from the martial *Warrior* and *Victor* to the Olympian *Jupiter* and *Juno;* Inveraray boats, from the old *Dunoon, Duntroon,* and *Inverary Castles* to the dashing *Lord of the Isles,* which now makes the long run from Glasgow to Inveraray and back in the summer season, so that it is no longer a "far cry to Loch

Awe." The West Highland boats stretch from the *Comet* through a series of big and little crafts to the *Columba*, which can carry 2000 passengers on a Fair Saturday without "feeling it." Some of them, like the *Cygnet*, *Plover*, and *Lapwing*, were little dumpy things made specially to go through the Crinan Canal, so small that it is said the captain of one of them told a heavy drover that used to travel with him "to keep away from the side and stand in the middle of the boat, or he would be upsetting it." *Eagles*, *Plovers*, *Merlins*, *Ospreys*, *Flamingoes*, *Petrels* have from time to time flown across our waters; *Pioneers* and *Pilots* have shown the road; *Spunkies* and *Kelpies* have glanced through the waves; *Vulcan* and *Neptune* have tried to rule them; as also *Sultans*, *Sultanas*, and *Viceroys*. The *Pioneer*, *Petrel*, and *Pilot* came on as railway boats on the Rothesay route as far back as 1845. They connected at the old Greenock or Custom-house Quay with the Glasgow and Greenock Railway. In later years the Glasgow and South-Western Railway Company from Princes Pier made their connection, the smart *Sultana* being well known on the Rothesay route; the Wemyss Bay Railway Company from Wemyss Bay have also their well-known fleet of white-funnelled boats carrying many thousands of passengers from the busy city to the Largs and Rothesay shores. Fifty years ago only seven steamers plied between Glasgow and Rothesay, the horse-power of each varying from fifty to seventy, the speed being eleven miles per hour. The fares to or from Glasgow were—cabin, 2*s.*; steerage, 1*s.* 6*d.* The first steamers which made the passage to Rothesay in 1814

had only a speed of six miles per hour. A large fleet of steamers now call at Rothesay during the height of the summer traffic, their horse-power varying from 1000 to 2000, and with speeds of 17 to 20 miles per hour.

Speaking of our Clyde steamers a writer in an American paper says: "Although England has a greater fleet of ships, both of war and of peace, than all the rest of the world put together, she is just a little short of fine, roomy, piazza-surrounded cabins, such as can be found on almost any American river. The trouble with British rivers seems to be that almost as soon as they become navigable they empty into the sea, and so all steamers have to be built like ocean liners, where comfort has to give way to safety. However, the Clyde, the mother of the finest steam-ships in the world, shows that it is possible to combine comfort and elegance with great speed and safety. For years the *Iona* held the palm, but now she gives the first place to her more recent sister, the *Columba*. This steamboat does not present the three or four storey appearance of some of the American boats, nor has it their dazzling whiteness, nor the easy undulating walking-beam. Taking the *Columba* as the finest specimen of passenger craft afloat in Great Britain, I must say that as far as outside appearance is concerned she does not come up in beauty or picturesque effect to many of the boats of the New World. It will be hard to make a Glasgow man believe this; but if he doesn't he should go over to America and see for himself. I haven't the *Columba* before me as I write, but my remembrance of her is a long steamer with side wheels, a mast in front, two large rakish

red funnels, a great length of cabin aft, and a fine promenade deck above it. She seems as steady and solid as a rock, very little motion being felt, and at full speed races easily along like an express train. The cabin seems like a very much magnified Pullman car. There is a glow of crimson velvet from the seats, and a general sunset hue pervades the entire saloon, toned down by the milder splendour of the carpet and the richness of the hangings and wood-work. The cabin is surrounded by a continuous window of the clearest plate glass, and as the seats are ranged facing the front and rear as in a Pullman car the traveller can sit there, no matter what the amount of the outside rainfall is, and have a series of landscape scenes presented to him that would be hard to equal anywhere else in the world." The *Columba*, built and engined by Messrs. J. & G. Thomson of Clydebank, measures 316 feet in length, and is built of steel with steel boilers. There are two oscillating engines, each cylinder being 53 inches in diameter, with a stroke of 5 feet 6 inches.

The *Columba* is the largest of our river steamers, and is one of the large fleet of well-known red-funnelled West Highland boats owned by Mr. David MacBrayne. Amongst them is the *Inverary Castle*, built and engined by Tod & M'Gregor in 1839, and now the oldest steamer plying on the river.

In order that some comparison may be made between typical river steamers of our own and American waters, the following descriptions of American steamers are appended: The *Mary Powell*, a famous Hudson River boat, measures 280 feet by 33½ feet beam, with a

draft of 6 feet; displacement, 757 tons. She is fitted with a beam-engine, working up to about 2000 horse power. The cylinder is 72 inches in diameter and 12 feet stroke. The paddle-wheels are 31 feet in diameter. The boilers are return tubular, having 154 square feet of grate surface, and 4700 feet of heating surface. The coal consumpt is at the rate of 40 lbs. per square foot of grate, with fan draught. Speed about 20 miles per hour. The steam is cut off at about half stroke, giving a mean effective pressure of about 24½ lbs. per square inch. Professor Thurston says: "The performance of the *Powell* has been such as to make her probably the most famous craft of the type in American waters."

The *Pilgrim*, a newer and larger vessel, plies on Long Island Sound, from New York to the Fall River, is 374 feet long and 50 feet broad, or 88½ feet over the guards; 3483 tons gross. The engine, single, of the usual beam type. The cylinder is 110 inches in diameter, with a stroke of 14 feet; diameter of paddle-wheels, 40 feet; steam power, 40 to 50 lbs.; speed about 18 miles per hour.

A Clyde river steamer is managed very quietly by the captain, who, with a slight motion of his hand indicates his wishes to the steersman at the wheel when approaching a quay. The signalling to the engineer has long been done by a very simple code of knocks through means of an iron rod passing from the paddle-box to the top of the engine-room. Tradition says that this system was introduced by an old captain, who, being lame, carried a stick, with which he used to rap on the engine-house. The more complete telegraph disc instrument,

however, is now superseding the simple knocker—at least in the larger and smarter boats.

On the Thames the "call boy" still shouts his "Ease 'er;" "stop 'er;" "turn ahead slow at the wharf." Possibly the latter, as a direction to the engineer, indicates the reason of the continuance of this system, the tide running so strong in the Thames upwards, and the flow of the river and ebb being so strong downwards, that a more extended intimation of what is necessary is demanded. *Valentine Vox* and *Punch* have both brought out in their own way the characteristics of the Southern River, the various signals of transmission being somewhat in this fashion, as we find in an old volume of *Punch:* "'Stand by!' from the captain. 'Stand by!' repeated the midshipman of the engine hatchway. 'A turn or two ahead!' was the captain's next ejaculation. 'A turn or two ahead!' promptly issued from the lips of his diminutive echo. 'Move on easy!' 'Move on e—e—easy!' repeated the gallant youth. 'Stop her!' 'Stop her!' issued from the mouth of the youngster at the engine hatchway." These were the signals in vogue in 1842 on board the "*Phizgig*, fresh-painted and new-engined, with as powerful a boiler and as first-rate a cargo of Hetton's, Wallsend, as ever were stowed under hatches; the awning as white as a pocket handkercher', the seats as green as a First Lord of the Admiralty, and the binnacle polished like the steward's stew-pans." *Punch* by the way is rather hard on the 1842 Thames river boats. He says: "There are about thirty steam-boats running between London Bridge and Richmond, all of which have at different times run against the tide, while twenty-five

have had the benefit of the wind on some occasions. Sixteen have run aground, and twelve have run into fourteen, while the remaining six have dashed against the bridges."

The system of silent signalling by telegraph between the captain and the engineer seems to have been early introduced into the Atlantic steamers. Thus, in a description of the *Atlantic*, one of the Collins line, we read: "In the engine-room is a long box with five compartments, each communicating with a wire fastened like a bell-pull to the side of the paddle-box. These handles are marked respectively 'ahead,' 'slow,' 'fast,' 'back,' and 'hook on,' and whenever one is pulled a printed card, with the corresponding signal, appears in the box opposite the engineer, who has to act accordingly. There is thus no noise of human voices on board this ship. The helmsman steers by his bells, the engineer works by the telegraph, and the steward waits by the annunciator."

The steam-boat service on the Clyde has been carried on with great immunity from serious accidents, especially when we consider the large fleet which on a summer's-day plies from early morning till late at night, both on direct business and pleasure trips, including "moonlight" cruises away to the Highland lochs of the firth. It is now many years since a boiler explosion took place, and, indeed, only about three disasters due to this cause can be counted, viz.: those of the boilers of the *Earl Grey* at Greenock quay in 1835, the *Telegraph* at Helensburgh in 1842, and the *Plover* at Glasgow some years later. Occasionally we hear of a water-tube of a haystack

boiler giving way, with no worse result than the putting out of the fire. A crank-shaft, after having made thousands of revolutions daily for years, suddenly breaks and brings the vessel to a standstill for a time till assistance arrives.

The Clyde steamers are all weatherly boats, and can bear up against a stiff sou'-wester in the firth nobly; and, indeed, they would require to be able to do so, as the choppy sea raised in such gales, especially with an ebb-tide, is like that of the "channel," short and angry, and pitches the boat about in a wonderful manner. A graphic picture of the stormy nature of the outlying part of the firth is given in *Sketches of Highland Character*. A passenger goes on board the *Arab* lying at Greenock, ready to start for the West Highlands, and overhears the following colloquy:—

"'Ye'll think it'll pe a plowy nicht?' said a hairy-faced fellow, who had a plaid rolled tight round his neck, as if he had serious thoughts of doing himself a grievous injury.

"'Ay will it,' answered a short squat man in moleskins, all covered over with coal-dust. 'Ye see the clouds, hoo they chase ane anither; that's a gran' sign o' wind. We'll hae a dance on the Moil the nicht, or I'm mista'en. There is plenty o' that afore us, or the winter is ower.'

"'No toot o' that; but ye're accustomed to it, and 'ill no mind it.'

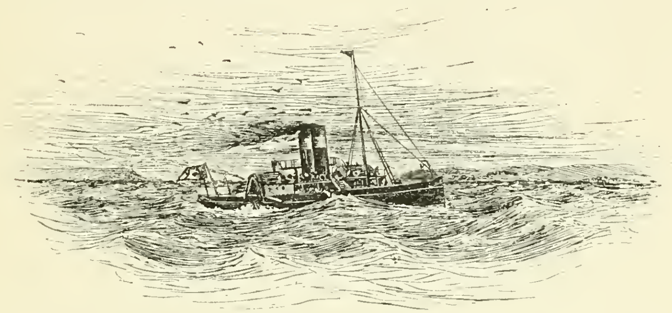
"'We wadna need, Dougald, for mony's the awfu' nicht we hae o' it on the Mull of Cantyre.'

"'It'll pe sometimes washing ower the feshel?'

"'Washing ower the veshel! ay, man, sometimes wash-

ing ower the funnel, and near puttin' out the fire on us, and wad do sae if the smoke dinna keep it frae coming doon.'"

The wrecks, however, don't count more than two or three altogether. The *Mars*, an old Largs steamer, went ashore in a gale after her engine broke down; and the *Lady Gertrude* took the rocks at Toward Point, due to a like cause, her ribs remaining for long, showing at low-water gaunt and grim; the *Eclipse* managed to run her-



Rough Weather on the Clyde.

self ashore on the Gantocks reef, off Dunoon. Collisions are also of rare occurrence, although occasionally at times such an accident occurs when two boats are trying to take a pier in a hurry. And as a good many accidents have nearly happened in like situations, due not only to the rivalry of the steamboat captains, but to the desire for speed and rapid transit on the part of the passengers, steps have been taken to erect proper signalling arrangements, somewhat after the railway system, under the charge of the piermaster, whose duty will be to

signal which steamer has the right to approach the pier. This racing between rival boats has for long been indulged in, when opportunity offered; but as the danger from explosion may now be regarded as eliminated, due to improved materials and construction of boilers, and also to Board of Trade loaded safety-valves, the risks are very slight to the passengers. The boats being skilfully handled keep quite clear, unless when approaching a quay, when by coming too near each other they may rub some of their paint off, or get the side-planks of a paddle-box crushed in.

During an early competition for passengers on the river, and consequent low fares, a story is told of a fishwoman who intended travelling to Greenock by the *Albion* (which was a kind of luggage boat carrying passengers), shortly after the *Earl Gray* was blown up in 1835. The would-be passenger asked the captain if it was true that he carried passengers for sixpence. He said, "Yes." "But," she replied, "is there nae fear o' bein' blawn up?" "Oh, no," said the captain; "we canna afoard to blaw ye up for sixpence."

Many of the Clyde river-steamers have wandered far from their early home, and found final resting-places on foreign shores and beneath the ocean waves. From the very earliest Clyde-built boats went off to England and France, to ply on the rivers there; this was only what might have been expected, from the fact of the Clyde being the birthplace of steamboat navigation. At certain times they departed, like some of the finny tribe, in shoals; thus about 1856 a number of our finest river steamers were sold for service on the Australian rivers,

some of them coming to grief on the way. Again, during the American Civil War, blockade-runners were much in request amongst the smart steamers of the Clyde. Curiously enough an old Clyde steamer, after acting as a blockade-runner, has now managed to get to the great lakes of North America, plying between Toronto and Niagara, on Lake Ontario.

Unfortunately the splendid river service of steamers is accompanied by much troublesome smoke and falling soot. Possibly the "haystack" boiler commonly used accounts for this, as the heated gases from the furnace shoot quickly through the various uptakes to the funnel. The stoke-holes are also necessarily limited, and we can hardly expect the stoker to remain longer below than necessary, hence his tendency to shovel in a good quantity of coal at a time and then ascend to the deck for a smoke himself. In the old days it was considered the proper thing to have a long pennant of black smoke streaming from the high and narrow funnel. Possibly as the early steamers were called by some the "reek boats," the association of smoke and the power within were closely identified.

STEAM SHIPPING.

As in making the Clyde a navigable river there were many eminent names, connected with the works, brought forward from time to time, so in the special and leading industries on its banks, both in ship-building and engineering, there are many names which have become household words, and will be honoured in the future as in the past.

Henry Bell, whose monument stands beside the old fort of Dunglass, overlooking the river which his enter-

prize has rendered famous amongst the rivers of the world as the cradle of European steam navigation, started his *Comet* in 1812. Bell was a clever, enterprising man, and appears early to have turned his attention to steamship propulsion, as in 1800 he tried some experiments in this direction, and in the same year laid his plans before the Admiralty, but without a successful issue. Lord Nelson, however, thought differently, and with a deeper insight into the future than his colleagues, said: "My Lords and gentlemen, if you do not adopt Mr. Bell's scheme other nations will, and in the end *vex every vein* of this empire. It will succeed, and you should encourage Mr. Bell." The practical success was indeed very soon shown in America, where Fulton, with a native-built boat and a Boulton & Watt engine, started the *Claremont* on the Hudson, and it was not till about five years later that Bell managed to get his long-cherished scheme accomplished.

The *Comet*, begun in 1811, and launched in 1812, has several well-known names associated with her, as she was built by John Wood, of Port-Glasgow, "the father of all that is best in the style of our ships, and truest in the practical application of science in the ship-building trade of Great Britain."[1] David Napier, afterwards so celebrated in connection with the development of the steamship industry of the Clyde, made the boiler. Bell's *Comet*, after undergoing various changes, was wrecked off Craignish, on the west coast, in October, 1820, and the engine was afterwards recovered and finally placed in the Museum at South Kensington, London. Bell was on

[1] Mr. Robert Duncan's Presidential address, Inst. Engineers and Ship-builders in Scotland, session 1872-73.

board the *Comet* at the time of the disaster, as he had gone especially with the view of getting subscribers for a bigger and more powerful boat. This was now gone into vigorously, the West Highland lairds coming forward readily, and in 1821 *Comet* No. 2 appeared, which, after plying for some time to Inverness, was sunk by collision with the steamer *Ayr*, off Gourock, on 20th October, 1825; upwards of seventy people were lost in this disaster. The vessel was afterwards raised and many valuable articles recovered.

Henry Bell was born at Torphichen Mill, near Linlithgow, on the 7th of April, 1767; he died at Helensburgh on the 14th November, 1830, and was buried in the churchyard of Row, in the neighbourhood.

That the early attempt by Bell had all the elements of after success in it, appears from the following statement drawn up by well-known early Clyde engineers:

"Glasgow, 2nd April, 1825.

"We, the undersigned engineers in Glasgow, having been employed for some time past in making machines for steam vessels on the Clyde, certify that the principles of the machinery and paddles used by Henry Bell in his steamboat the *Comet* in 1812, have undergone little or no alteration, notwithstanding several attempts of ingenious persons to improve them.

Signed by Hugh and Robert Baird, John Neilson, David and Robert Napier, David M'Arthur, Claud Girdwood & Coy., Murdoch & Cross, William M'Andrew, William Watson."[1]

Professor Rankine also remarks, in speaking of this introduction of steam power: "Since that period the advancement of steam navigation has consisted not so

[1] *Life of Henry Bell*, by Edward Morris.

much in the development of new principles, as in the improvement of workmanship, arrangement, and economy of fuel, and the progressive increase of the size, power, and speed of steamships, and the extent of their voyages."

The whole subject of the introduction and development of steam propulsion is one of great general interest, as illustrating the application of mechanical skill and inventive genius in overcoming difficulties; yet, in any general account of the progress from the early periods until now (as the field is so wide and the interval of time great since the first feeble attempts were made on inland rivers to use the power of steam), we lose the more salient points in the development because of the wide-spreading results with which we are at the present day so familiar. For the last half-century we have been living in an age of steam. In 1765, James Watt, while repairing a model of a Newcomen engine belonging to the natural philosophy class of the University of Glasgow, made his discovery of the separate condenser. This afterwards, applied practically with many other beautiful mechanical inventions, gave vigour to a machine which formerly, from its elementary form and rude construction, had been limited to the pumping of water. Although Watt made his discovery in 1765, it was not till the year 1784 that we find him writing: "Our rotative engines, which we have now rendered very complete, are certainly very applicable to the driving of cotton mills, in every case where the conveniency of placing the mill in a town, or ready-built manufactory, will compensate for the expense of coals and of our premiums."

As yet the steam-engine was on its trial, and encoun-

tered great opposition ere it won its way by sheer force of applicability to the many operations gradually opening up. In reference to the great invention of James Watt, the late Professor Macquorn Rankine says: "Watt set to work scientifically from the first. He studied the laws of pressure of elastic fluids, and of the evaporating action of heat, so far as they were known in his time; he ascertained as accurately as he could, with the means of experimenting at his disposal, the expenditure of fuel in evaporating a given quantity of water, and the relations between the temperature, pressure, and volume of steam.

James Watt.—From a print by Holl, after Sir W. Beechy.

Then, reasoning from the data which he had thus obtained, he framed a body of principles expressing the conditions of the efficient and economic working of the steam engine, which are embodied in an invention described by himself in the following words, in the specification of his patent of 1769: "'My method of lessening the consumption of steam, and consequently fuel, in fire engines, consists of the following principles:

"'Firstly, that vessel in which the powers of steam are

to be employed to work the engine, which is called the cylinder in common fire-engines, and which I call the steam-vessel, must, during the whole time the engine is at work, be kept as hot as the steam that enters it; first, by inclosing it in a case of wood or any other materials that transmit heat slowly; secondly, by surrounding it with steam or other heated bodies; and thirdly, by suffering neither water or any other substance colder than the steam to enter or touch it during that time.

"'Secondly, in engines that are to be worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from the steam-vessels or cylinders, although occasionally communicating with them. These vessels I call condensers; and whilst the engines are working, these condensers ought at least to be kept as cold as the air in the neighbourhood of the engines by application of water or other cold bodies.

"'Thirdly, whatever air or other elastic vapour is not condensed by the cold of the condenser, and may impede the working of the engine, is to be drawn out of the steam-vessels or condensers by means of pumps, wrought by the engines themselves or otherwise.

"'Fourthly, I intend, in many cases, to employ the expansive force of steam to press on the pistons, or whatever may be used instead of them, in the same manner in which the pressure of the atmosphere is now employed in common fire-engines. In cases where cold water cannot be had in plenty the engines may be wrought by this force of steam only, by discharging the steam into the air after it has done its office.

"'Lastly, instead of using water to render the pistons

and other parts of the engines air and steam tight, I employ oils, wax, resinous bodies, fat of animals, quicksilver, and other metals in their fluid state.'"

The earlier forms of the Watt engine had wooden "walking-beams." An example of such an engine may be seen near the Museum in the Kelvingrove Park of Glasgow, where it was re-erected some years ago. Iron was afterwards substituted for the wooden beam, and so designed as to give a maximum of strength, to resist the heavy strains coming upon it, with a minimum of weight. The beam-engine still holds its place as a reliable engine for mill work, and the Americans have retained it for their steamers at least on the eastern waters and coasts. Watt's prolific brain thought out from time to time many important inventions which proved useful in the development of the steam-engine.

In 1812 we start with the *Comet,* and by 1814 we have in all seven steamers which had been built up to that year, including the *Industry,* which, as the seventh steamer built on the Clyde, is, as already stated, still in existence at the age of seventy-four, lying rotting away in Bowling Harbour (see cut on p. 229). In 1820 we find the number of steamers as given in the *Steamboat Companion* for that year plying on the Clyde to be twenty-four, nine of which (including the first *Comet*) extended their voyages to Fort-William, Campbeltown, Belfast, and Liverpool. In 1828 the number, according to Dr. Cleland, extended to fifty-nine, twenty-five of which were sea-going boats; Liverpool and Dublin being, however, as yet the farthest ports ventured to. In 1836, another step of eight years, we find recorded in *Fowler's*

Commercial Directory for Renfrewshire seventy-eight steamers as calling at Greenock, of which thirty-one were for Liverpool, Dublin, Belfast, and generally ports beyond the end of the firth. The voyages of the *Sirius* and *Great Western* to New York in 1838 and the establishment of the Cunard Co. in 1840 brings us to the period of ocean-going steamers, and the interest in the river and coasting boats built or plying on the Clyde ceases to have a paramount interest.

The engine of the *Comet*[1] was of a somewhat peculiar form, called a bell-crank arrangement, and, like a number of the earlier engines, was connected to the paddle-wheels by spur gearing. Afterwards the side-lever engine was commonly employed in sea-going vessels, and the steeple and oscillating engine on river boats. The custom in this country at least was to work the steam at low pressure with the aid of the condenser. In some cases, however, high-pressure steam was used; but its progress was checked by the disastrous explosions which occurred, notably in the case of the *Telegraph* at Helensburgh and the *Cricket* on the Thames. Broadly speaking we had at first a period of wooden boats, bluff-bowed and broad in proportion to length, driven more or less by side-lever engines, the propellers being paddle-wheels with fixed floats. A single long narrow funnel rose abaft the paddle-box, and the vessels were heavily sparred and rigged. Copper boilers in many cases were used, and steam pressures of from 5 to 10 lbs. were common. The jet condenser was in use, and the steam, when

[1] A model of the *Comet*, also likenesses of Mr. Robertson, together with paintings and models of early steamboats, may be seen in the Kelvingrove Museum.

unused, was blown from a steam-pipe led up alongside the funnel with a roaring noise. By a simple arrangement it can now quietly escape into the water. The regulating of the escape in the old boats was managed through a safety-valve loaded with a series of disc-shaped weights, which could be adjusted on the spindle of the safety-valve, placed upon the steam-chest, immediately adjoining the funnel, and manipulated from the deck by a stoker or attendant engineer.

The use of iron for shipbuilding did not become general till about thirty-five years after the *Comet* was launched. Some early attempts are recorded to have been made with canal boats both in England and Scotland. John Wilkinson, of Lancaster, about the year 1750 made an iron boat, and in 1787 another was tried on one of the Staffordshire canals. In 1818 an iron boat named the *Vulcan* (designed by Sir John Robinson, of Edinburgh, in 1816) was built at Faskine, on the Monkland Canal, by Thomas Wilson. This boat plied for a number of years on the Forth and Clyde Canal. Wood has now almost disappeared as a building material for our vessels; but on the Continent fully one-half of the vessels are still built of that material.

The great drawback to the use of steam of a high pressure in these times was the weakness of the boiler. Watt from the first clearly saw the advantages in economy which would arise from its use, but was unable, from the imperfect mechanical appliances of his time, to obtain the necessary resisting strength in the material employed.[1]

[1] Nominal horse-power conveys at the present time little idea of the efficiency of the machinery, but in the days of Watt it was such a measure, the pressures

In a few years after Bell's *Comet* a goodly number of steamers were plying on the Clyde, built and engined by different constructors; some of these men ultimately rose to much distinction. The name of Jas. Cook early appears as the engineer for several of the early boats; thus the next steamer after the launch of the first *Comet* was the *Elizabeth*, started on 9th of March, 1813. It was engined by James Cook of Tradeston, as were a number of others later on. David Napier is specially connected with the sea-going vessels, as in 1818 the *Rob Roy* was engined by him with a single side-lever engine, a type much developed in later years. This vessel was built by William Denny of Dumbarton, and thus we find a well-known name on the Clyde appearing amongst the early builders of our sea-going vessels. This same builder's name, however, appears as early as 1814, when he built the river boats *Trusty* and *Marjery*. The *Rob Roy* plied to Belfast, and was afterwards on the Dover and Calais route. In 1817 Mr. Napier, like Mr. Seath at a later date, tried the running of a steamer above the bridges.

The name of Robert Napier, however, is linked to others who took a leading part in the development of ocean-going steamers. We find the history of events bringing us in contact with great commercial undertakings, and one more especially where the Clyde and the Mersey in some measure joined hands. In 1824 the firm

at that time being only about 7 lbs. on the square inch, with a piston speed of 240 feet per minute. With the higher pressures now used and greater piston speeds, the indicated horse-power is about five times the nominal. Nominal horse-power, as a commercial term, may be calculated by squaring the diameter of piston in inches and dividing the result by 12 for a non-condensing engine, and by 24 for a condensing engine.

of Messrs. G. & J. Burns was started, their vessels plying to the North of Ireland. In 1828 they built their first steamer for the Liverpool traffic. Mr. Napier became early associated with these movements, and thus we find that in 1840, when the Cunard Co. was established, and in the formation of which the Messrs. Burns and Mr. Napier took a leading part, his engines were placed in the first steamer of the company, and the steamers themselves were all built on the Clyde by such well-known firms as those of Duncan, Wood, and Steele.

Robert Napier.—From a photograph, kindly supplied by Henry M. Napier, Esq

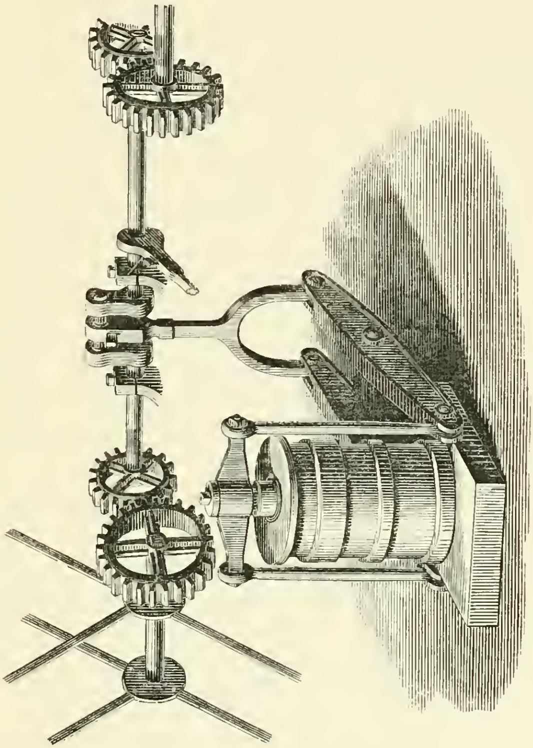
In connection with this it is interesting to notice that the four vessels with which the Cunard Coy. started in the Liverpool and American service in 1840, viz. the *Britannia, Acadia, Caledonia,* and *Columbia,* all wooden paddle boats of about 1100 tons burthen each, have been year by year added to until the total number of boats used since that time amounts to fifty-nine. After passing through the period of iron, with paddle or screw, they are now built of steel, with screw-propellers, such ships as the *Umbria* and *Etruria* being of about 8000 tons burthen. The large paddle ships culminated in the

Scotia, also built for the Cunard Co. by R. Napier & Sons in 1861. The dimensions of this boat were: Length, 366 feet; breadth, 47 feet 6 inches; tonnage, 4050. She had two side-lever engines of a nominal horse-power of 1000. The diameter of the cylinder was 100 inches; stroke, 12 feet. The paddle-wheels were 40 feet diameter, and the size of the floats 11 feet 6 inches by 2 feet. Time of passage to New York, 9 days. This, the last paddle steamer of the Cunard Co., was a very different vessel from their first steamer the *Britannia*, no doubt considered a wonderful boat in her day. The side-lever type of engine is illustrated by the figure on p. 211, which shows the engine of the *Industry*, and also the spur-wheel connection used in the older boats.

The first iron steam-vessel was the *Aaron Manby*, made at "Horsely" in 1821, and put together at London. This vessel plied on the Seine. The first iron steamer built on the Clyde was the *Aglaia* in 1827. This vessel plied on Loch Eck. The first iron steamer to ply on the Clyde was the *Fairy Queen*, built in Glasgow at the Old Basin, about a mile and a half from the river, to which she was carried, and launched in 1831. This vessel plied to Largs about 1836. The *Vanguard* was the first iron vessel built by R. Napier at Govan (1843). She plied for many years on the Glasgow and Dublin route.

The use of wood, however, continued for many years, all the early Atlantic steamers being built of this material; and it was not till 1856, when the *Persia* was added to the celebrated Cunard fleet, that that company introduced iron for the hulls of their vessels. The firm of

Tod & M'Gregor is associated with the first iron sea-going steamer, the *Royal Sovereign*, built in 1839. She was engined by this firm and plied to Liverpool. The



Engine of the Industry.

firm of T. Wingate & Co. had the special honour of having made the engines of the first steamer which crossed the Atlantic from Britain, the *Sirius*, built in 1837 by Menzies & Sons, of Leith. The engines were of

the side-lever class, and had the special feature of being fitted with Hall's Surface Condenser. The name of Caird & Co., of Greenock, is specially associated with the start of the deep-sea boats belonging to the firm of Messrs. G. & J. Burns, as in 1828 they engined the *Glasgow* for that company. The engines were side-levers, the steam pressure being 5 lbs. per square inch. The *Liverpool*, a bigger ship than the *Glasgow*, was added to the same company's fleet in 1830, and was built by Steele & Co. of Greenock. The *Atrato* for the West India Royal Mail Steam-Packet Co. was built and engined by Caird & Co., at Greenock, in 1854. Dimensions: 315 feet long by 42 feet broad, and 26 feet 6 inches deep; gross tonnage, 3466; diameter of cylinder, 96 inches; stroke, 9 feet; nominal horse-power, 800. The paddle-wheels had feathering floats. The average ocean speed was 13·3 knots, with an average daily coal consumpt of 100 tons. The *Atrato* was an iron vessel.

Experiments were being made from time to time with the screw-propeller, early attempts being made with a screw or helix of several turns. Stevens, at New York, tried a small vessel on the Hudson in 1802. The engine and propeller can still be seen at the Stevens' Institute, Hoboken. The engine is placed vertically, and geared by a spur-wheel to the propeller shaft. Smith and Woodcroft in this country, and Ericsson in America, also tried various arrangements; and in 1840 the late Captain Kincaid of Greenock tried a four-bladed propeller in a steam-boat on the Forth and Clyde Canal. But previously to that, and as early as 1828, Captain Kincaid made a wooden four-bladed propeller, and ex-

perimented with it on a long-boat in mid-ocean. The actual propeller then used is now in the Kelvingrove Museum. The first British steamer fitted with a screw-propeller was the *Archimedes,* 237 tons, and built on the Thames in 1839. This vessel appears to have come up to Glasgow on a trip. The first screw-ship in H.M. navy was the *Dwarf,* an iron vessel, built in 1843.

The *Great Britain,* built in 1843, was the largest vessel of that day. It may be interesting to state some particulars of this ship as noted at the time,[1] as she was a departure in several ways from what had gone before, both in size and method of propulsion. In the journal referred to we find amongst other details that "the *Great Britain* is no doubt an object of great interest; she differs from every other steamer which has ever crossed the Atlantic; she is the largest—she is built of iron—and she is propelled by the screw instead of paddles. She is thus destined to test three principles:—The first as respects size. The advantage of iron over wood as a material for marine architecture may already be considered as established; but the trial of the Screw *v.* Paddle is yet pending for want of sufficient evidence." The *Great Britain* still, or until recently, running, after nearly half a century's service, was designed by Brunel, and built at Bristol. She was launched after some difficulty, on account of her unprecedented size, in 1843. From an advertisement notifying her sale in 1881, the dimensions are given as—length, 274·2 feet, or 322 feet over all; breadth, 48·2 feet; depth, 31·5 feet; 3270 gross tonnage. Engines by J. Penn & Sons, Greenwich; and

[1] See *The Practical Mechanic and Engineer's Magazine* for 1843.

boilers by Fawcett, Preston & Co., Liverpool. Strongly built of Low Moor iron of the finest quality. This vessel plied with much satisfaction in the Australian trade. The propeller was 16 feet diameter; the main shaft was hollow, measuring 28 inches diameter outside and 10 inches inside: this part being bored out and a stream of water sent through it to keep the bearings cool. The engines were geared to the shaft. The *Great Britain*, like the *Great Eastern*, made her first trips across to New York, the passage being fifteen days. In one of her outward trips, by a mistake as to the lights, she got ashore in Dundrum Bay on the Irish coast, and lay there for a considerable time. This event, occurring to this wonderful ship of the time, was reckoned sufficiently notable to be illustrated in one of the views of a panorama which came to Glasgow after the mishap; the describer carefully pointing out to the spectators the position of the "propeller," which could be easily seen, as the vessel was shown at low-water, pretty much high and dry.

Shortly after this, in 1845, the first iron screw-steamer, the *Fire Queen*, was built at Glasgow; and in 1850, the *City of Glasgow*, of 1609 tons, commenced to ply between Glasgow and New York. This vessel was built by Tod & M'Gregor, and was an iron screw-steamer of 1600 tons, measuring 227 feet long by 32 feet 7 inches broad, and 24 feet 7 inches deep. She had two geared beam-engines of 380 horse-power; the propeller was 14 feet diameter.

The *City of Glasgow* left Glasgow on the 16th of April, 1850, and arrived in New York on the 3d of May, after a passage of 16 days 21 hours. She encountered head

winds; her greatest day's run was 241 knots. The return voyage was made in 14 days 6 hours; greatest day's run, 263 knots.

Attempts were made from time to time to increase the effective action of the paddle-wheel, the feathering float being the most important improvement. (See cut p. 216.)

The *Glasgow*, which followed her, was the first steamer belonging to the Inman Company, so long well-known on the Atlantic route for its swift and commodious steamers. This company, under the new designation of the Inman and International Company, are at present having two very large Atlantic liners built and engined on the Clyde by Messrs. J. & G. Thomson, Clydebank; twin-screws of about 10,000 tons, with corresponding power and equipment.

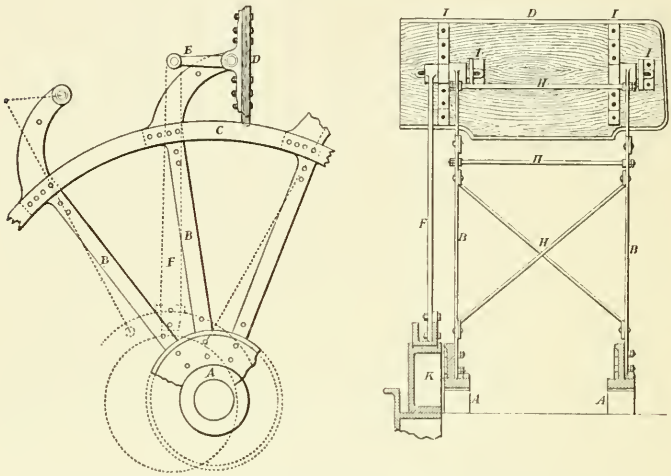
The *Glasgow* left Glasgow for New York on 16th September, 1857, and arrived on the 30th of the same month; the greatest day's run was 254 knots. She left New York on the 11th and arrived in the Clyde on the 28th October; greatest day's run, 262 knots.

The dimensions of the *City of New York* now launched are: length on water-line, 525 feet; breadth, 63¼ feet; depth, moulded, 42 feet; tonnage, 10,500. This vessel is fitted with twin-screws and triple expansion engines.

The Collins line, belonging to the United States, started in 1850, and continued to run for about ten years; their vessels were large paddle-wheel steamers.

It is just about thirty years since the iron vessel and screw-propeller may be said to have taken a prominent place in the history of naval architecture. About the time of the introduction of the screw-propeller for ocean-

going vessels it was thought by some that a modified application might prove commercially successful; and this gave rise to auxiliary screw-propellers, the idea being to aid the force of the wind upon the sails by means of steam-power applied to a screw-propeller. To



Part of Paddle-wheel, showing arrangement for Feathering Floats.

A, Paddle-wheel Centre-boss; B B, Arms; C, Rim; D, Float; E, Arm for Float. F, Driving-rod; H H, Stays; I I, Brackets; K, Fixed Eccentric.

test the correctness of this, a vessel was built at Liverpool in 1846, called the *Sarah Sands*, of 1100 tons, and made several voyages between that port and New York, her passages occupying about seventeen days. This vessel was nearly destroyed by fire in the Indian Ocean while conveying troops during the Indian mutiny. For the following incidents the author is indebted to one of the passengers:—The vessel sailed from Portsmouth on 15th

August, 1857, having on board 350 officers and men of the 54th Regiment; on the 11th November fire broke out, and raged so furiously that it was only through the military discipline that it was got under; to add to the danger, during the conflagration some powder exploded in the after-part of the ship. The women and children were placed in boats and rafts which lay alongside. The iron got white-hot, and the masts went overboard, but finally the fire was extinguished and some sail got up. The boats lying around were then taken in. They had been followed by shoals of sharks, which had been attracted by the light and the prospect of making the castaways their prey. The chronometer was lost, and the watches of the officers were used instead. A course was set for the nearest land, the Mauritius, 1000 miles distant, and the weather fortunately remaining fine, the battered craft and miserable-looking ship's company arrived safely on the 23d November.

Another incident of the sea may be mentioned in connection with the *Three Bells*, built at Dumbarton by Messrs. Wm. Denny Brothers in 1851. She was the largest iron sailing ship afloat at the time, and during one of her voyages came upon the *San Francisco*, a United States transport, which had a number of troops on board. As this vessel was in a sinking condition the captain of the *Three Bells* determined to stand by them till morning, so that help might be given, which incident has been described by the poet Whittier in the following lines:

> " Beneath the low-hung night cloud
>   That raked her splintering mast

The good ship settled slowly,
The cruel leak gained fast.

"A voice came down the wild wind,
'Ho! Ship ahoy!' its cry:
Our stout *Three Bells* of Glasgow
Shall lay till daylight by!'

"All night across the waters
The tossing lights shone clear;
All night from reeling taffrail
The *Three Bells* sent her cheer.

"And when the dreary watches
Of storm and darkness passed,
Just as the wreck lurched under,
All souls were saved at last."

The firm of Randolph & Elder is inseparably associated with the successful introduction of the compound engine, as that of R. Napier & Sons is now with the triple-expansion system. In a memoir of John Elder, by the late Professor Macquorn Rankine,[1] we find that Elder mastered the subject of reduction of friction by neutralizing the forces which drive the shaft. In 1853 they patented vertical direct-acting and geared compound engines for driving a screw-propeller; in 1856, two opposite cranks; in 1858, three cranks. The first vessel fitted with a compound engine by Randolph, Elder, & Co. was the *Brandon* in 1854, the consumpt of coal obtained being $3\frac{1}{4}$ lbs. per indicated horse-power per hour; formerly this consumpt had been as high as 4 to $4\frac{1}{2}$ lbs.

After this the Pacific Steam Navigation Company got

[1] *Trans. Inst. Engineers and Shipbuilders in Scotland*, vol. xv

two paddle steamers built—the *Inca* and *Valparaiso.* These were fitted with Randolph & Elder's compound engines in 1856, the consumpt being from $2\frac{1}{2}$ to 3 lbs., "a degree of economy never before realized in marine engines; and this was not only obtained on the trial trips, but maintained during many years' subsequent service at sea. It amounted to a saving of from 30 to 40 per cent of the coal previously burned by steamers of the same class." This great reduction of fuel now made long ocean passages commercially practicable.

In the *Memorials of James Watt*, published in 1856, it is stated that "at that time by far the largest proportion of steam-vessels launched in the Clyde are of iron," and "of the whole steam-vessels constructed on the Clyde, or in progress at the various building-yards in 1852, amounting in all to 73, only four were of wood; while the proportion of screws to paddle-wheels was as 43 to 30." The *Times*, treating of shipbuilding in 1883, says: "One fact, emphasized by the returns for the year under review, is, that wood has practically, if not absolutely, gone out of existence as a shipbuilding material. Iron is now the general material of which vessels are constructed, though steel is year by year coming to the front. This is particularly shown in the returns from the Clyde. Very few years have elapsed since the first steel ship was launched on the Clyde. Four years ago the entire output of steel vessels was 18,000 tons. In 1882 the quantity had been increased to fully 100,000, and in 1883 it rose to 120,000 tons, or nearly one-third of the whole tonnage launched, the proximity of steel-plate works, and the distance of the source of part of the

supply of iron plates undoubtedly contributing to that change. In the north-east ports the number of steel vessels built is much fewer. On the Tyne 12 vessels have been built of steel, and on the Wear 4. But in the Scotch and Irish ports this material is being increasingly used, and in addition to the Clyde, Grangemouth and Belfast have used it largely. Another fact prominently brought out is that sailing are speedily giving way to steam-vessels. Of the 326 vessels launched on the Clyde during the year, 240 are steam and only 86 sailing. On the Tyne not one sailing vessel has been built, and on the Wear one only. Taken all round, the size of the vessels has increased. The Clyde still holds its own for vessels of the largest class; but taking an average between large and small, the Tyne and Wear show larger figures than the Clyde. Roughly stated, the average is as follows:—Clyde-built vessels, 1210; Tyne, 1400; Wear, 1685."

The most of our great ocean liners of the present day are built of steel. This material, both in ship plates, angles, &c., and in boiler plates, has within the last few years largely replaced the use of wrought iron,—partly due to its greater strength, whereby less material is required; a very great advantage, when we consider the great weight of the vessels and boilers of the present day. The use of steel for shipbuilding is not, however, altogether new, as, about twenty-five years ago, some river steamers were built on the Clyde of that material.

Mr. Robert Duncan, speaking on the classification of shipping, gives the following statistics of the comparative

number of vessels built at ports in Great Britain in 1886:—

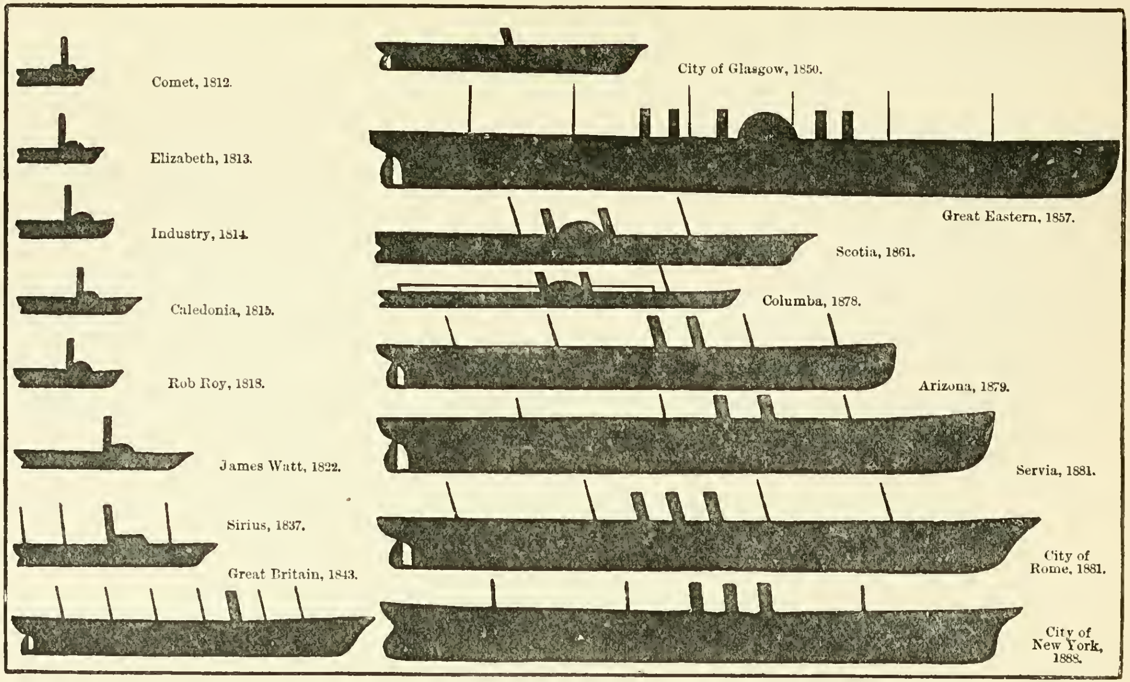
Built at London,...........	45	vessels of	3,696	tons.
„ Liverpool,........	16	„	18,268	„
„ The Tyne,........	50	„	49,614	„
„ The Wear,........	28	„	46,187	„
„ The Tees,..........	18	„	33,797	„
„ The Clyde,........	151	„	135,159	„

The consumpt of coal in all the earlier sea-going steamers was excessive, consequently the available space for merchandise was very limited, giving rise to the belief expressed at the time of the first ocean passages, that it would be impossible to carry on a commercially successful traffic with steam. In reference to this, Sir William Pearce, Bart., in a lecture delivered in 1881,[1] points out that the *Persia* burned 6·3 tons of coal for every ton of cargo she carried; whilst the *Gallia*, built in 1879, and fitted with screw-propeller and compound engines, burned only about half a ton of coal for every ton of cargo, and, besides, carried this cargo about two and a half knots faster. Still further, the *Arizona*, also built in 1879, burns only 5 cwts. of coal for every ton of cargo carried. The daily coal consumpt in the *Persia* was 150 tons per day, the indicated power 3600, or 3·7 lbs. of coal per indicated horse-power. In the *Gallia* the daily consumpt was 97 tons, the indicated power 5000, or 1·8 lbs. per indicated horse-power per hour. In the *Arizona* the daily consumpt was about 110 tons or 1·75 lbs. per I.H.P. The speeds of the *Persia*, *Gallia*,

[1] See lecture delivered during Naval and Marine Engineering Exhibition at Glasgow, 1880-81.

and *Arizona* were about 13 knots, 15½ knots, and 16¼ knots.

In connection with the subject of the size of our future sea-going steam-vessels, Mr. William Denny says (Watt Lecture, 1882): "Steamers were increasing in size, and the least costly increase for weight-carrying, and, up to certain points, for speed, was in beam, provided sufficient draughts could be obtained. Steamers would follow their natural course of development, and it would be for dock proprietors, river trustees, and harbour boards to see that their docks, rivers, and harbours were of such depth as to permit them to favour steamers so developed. He believed it was found daily more difficult to build the larger types of Atlantic steamers rigid enough for the service, even with the great percentage of their displacement devoted to structural weight. A reaction would set in against their extreme proportions and absolute length. When that happened, beam would be increased; as a consequence draught increased, and distinct preferences accorded to ports having great draught of water. Besides, great draught of water, and comparative shortness of a steamer, were more favourable to the efficiency of the screw, by keeping it well immersed, than great length with shallow draught, which told very much against the screw's efficiency." Mr. Denny further states that he he is "convinced that the steamer which was to do the Atlantic work would be a vessel of what might be called at the present time moderate length. That was a vessel which would not only be shorter than the *City of Rome*, but shorter than the *Servia*, and shorter than the *Alaska*, which, of the three steamers, as far as he could



Comparative Sizes of some early and more modern Steamships.

learn, came nearest the type he had in view. He believed the steamer to do this work would be under 500 feet in length between perpendiculars. What her other dimensions should be would have to be fixed by experiment and a very careful series of calculations."

The annexed diagram of the comparative sizes of some leading steam vessels was originally used to illustrate a lecture delivered by the author during the Naval Exhibition, held in Glasgow in 1880–81, under the auspices of the city authorities.

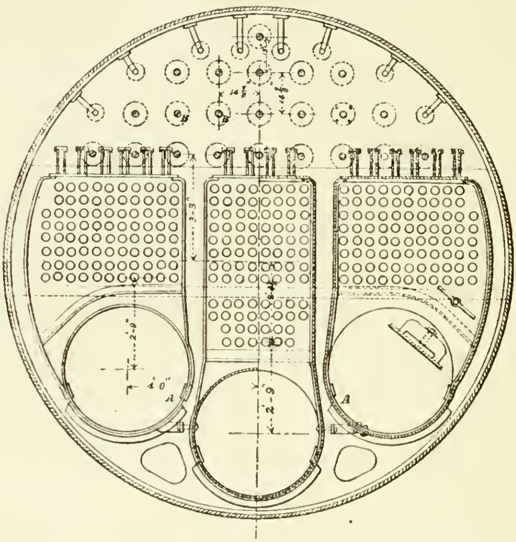
The compound engine, as introduced on the Clyde by Randolph, Elder & Co., in the first mercantile steamer fitted with this form of engine, the *Brandon*, in 1854, reduced the consumpt of fuel to a large extent. Later on, due to further improvements, such as surface condensation, the use of three cylinders instead of two, whereby the efforts on the shaft were more completely equalized, the consumpt was further reduced, until, in the latest compound engines, less than 2 lbs. of coal were required. Recently the triple-expansion engine has been introduced, whereby a further saving in coal is obtained. In this form of engine the expansive action of the steam is carried out through three cylinders consecutively—that is, it is admitted from the boiler into the first and smallest cylinder, and, after driving the piston of that cylinder before it for a part of the stroke, the admission of the steam is cut off, the rest of the stroke being accomplished by the expansion of the steam already admitted. Thereafter this steam passes into the next or intermediate cylinder, and presses forward the piston in that cylinder, and finally, as its expansive power is not yet exhausted, it is

allowed to enter the third cylinder, pressing forward in turn the piston there. The intensity of the pressure, as it enters the second or intermediate cylinder, is much less than when entering the first; but as this cylinder is made proportionately wider, and has therefore a greater area of piston, the total driving power on the piston is still obtained about equal to that in the first cylinder. The third cylinder is in turn larger than the second cylinder. Certain proportions have been adopted as best suited to equalize the pressures on the pistons, and from thence to the cranks.

The quadruple-expansion engine, of which a few have been made, is simply, like the triple-expansion engine, a development of the compound—that is to say, in the compound the steam was expanded through two cylinders, in the triple through three, and in the quadruple through four, higher pressures being required in the triple and quadruple forms than in the compound, as the range of expansion is greater. Here, however, we touch the main item in the increased economy of the later forms, and which may be shortly referred to.

Generally speaking, steam when expanding may be represented as following what is known as Boyle's law of gaseous expansion—that is, that the pressure varies inversely as the volume; so that if, in the triple-expansion engine above referred to, we suppose that the steam is cut off from the boiler after driving the piston through half of the stroke, or when one-half of the cylinder is full, then at the end of the stroke the volume of steam will be double of what it was when cut off. The pressure, therefore, will be only one-half of what it was before being cut

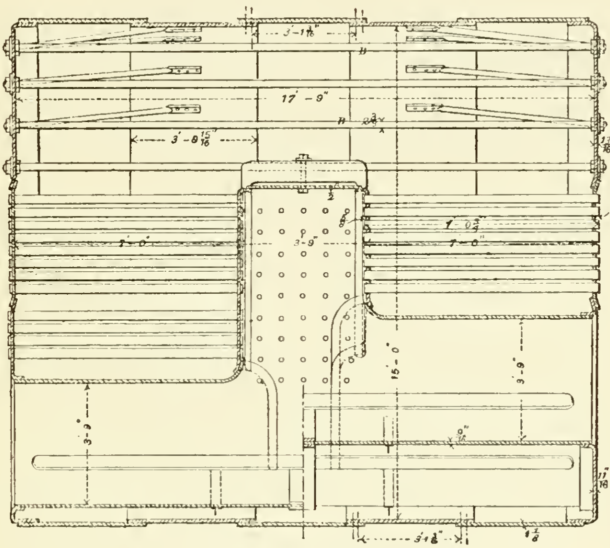
off—that is to say, the volume having doubled, the pressure has fallen to one-half. In like manner, when the volume has further increased—say to five times—then the pressure will be reduced to one-fifth. It will now be found that the mean pressure is higher when the expansion



Cross Section of Marine Boiler.

is considerable, in proportion to the steam used. Thus, if the steam were not used expansively at all the pressure would be uniform throughout the stroke; but a whole cylinder full of steam would be used. If cut off at say half-stroke, the mean pressure would now be approximately seven-eighths of what it was in the first case. But only one-half of the steam is now used.

It is, therefore, economical to use the expansive force of the steam; and to do this with the greatest effect a long cylinder or a series of cylinders is necessary. It is also necessary that the initial pressure be high, so as to take advantage of expansion to the fullest.



Longitudinal Section of Marine Boiler.

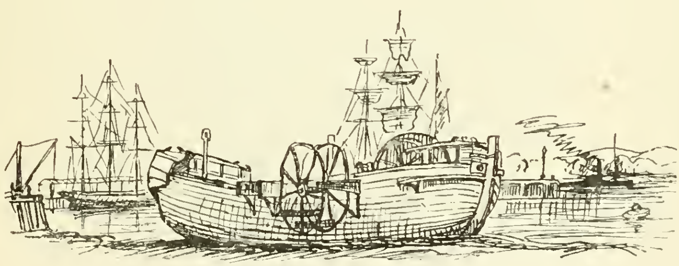
In the compound system, therefore, an advantage is gained; and in the triple and quadruple systems a still further improvement arises from the use of steam at a higher pressure and expanded more fully, whereby less steam can be made to give a better mean result. A saving is thus effected, both in coal consumed and in boiler space. Pressures have now reached 160 lbs. and

170 lbs. per square inch, and will, no doubt, go higher still. The limit of economical working cannot, however, be far off, as with increased pressure difficulties will be met from the greater heat of the steam affecting the working parts.

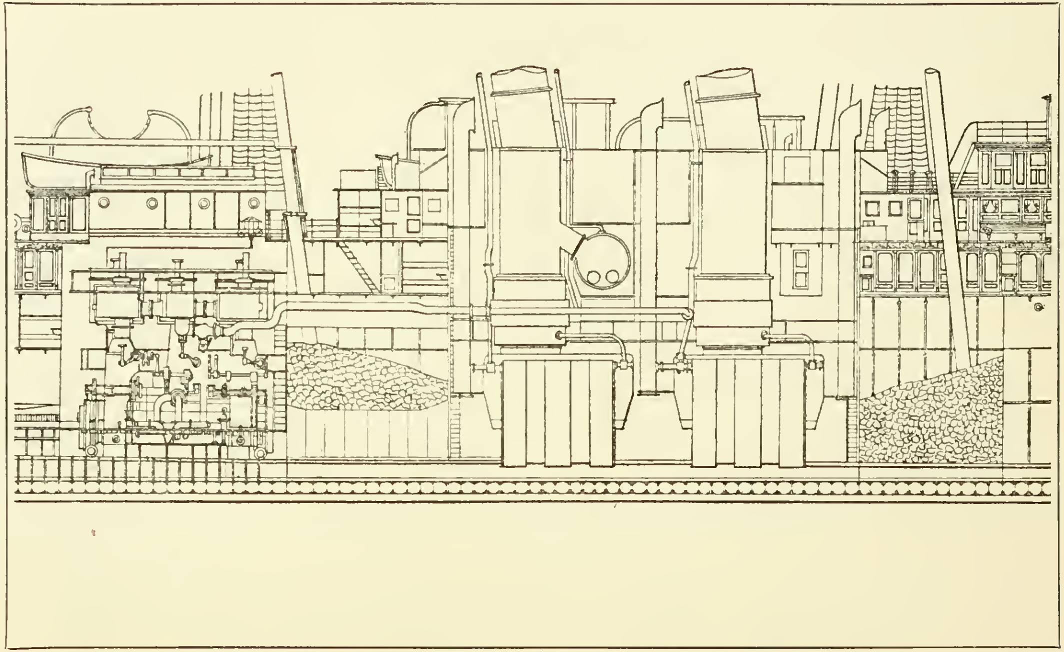
The whole question of economical working, in a word, depends upon the amount of effective work which can be obtained from the coal consumed. So that, not only is the engine subject to further improvement, but also the boiler and furnace. Combustion by forced draught, &c., are all elements in the question. From the combustion of 1 lb. of coal about 14,500 thermal units should be obtained. Roughly speaking, this energy may be stated to be expended as follows:—In the triple-expansion engines as now used at sea, we may take $1\frac{1}{2}$ lb. of coal consumed per hour as equivalent to one horse-power; but as one horse-power represents 33,000 foot-pounds of work done per minute, then the total work done by the combustion of the $1\frac{1}{2}$ lb. of coal in the hour is $33{,}000 \times 60 = 1{,}980{,}000$ foot-pounds. But it can be shown that from the combustion of one pound of coal 14,500 thermal units should be obtained, and consequently from $1\frac{1}{2}$ lb. 21,750 thermal units, which, multiplied by 772 (the mechanical equivalent of heat), gives 16,791,000 foot-pounds of work done in the hour; if, therefore, we compare the work actually done with the work which should be done if all the coal energy could be converted into useful work by the engine, we have this ratio: $\frac{1{,}980{,}000}{16{,}791{,}000}$, or only a little over one-ninth of the energy expended.

The triple-expansion system of marine engines was first tried in the *Propontis,* built in 1874, by Messrs. J. Elder. The diameters of the cylinders were 23, 41, and 62 inches respectively; steam pressure 150 lbs. Mr. William Parker[1] says: "The first engines made for sea-going purposes on the triple-expansion principle were those made in 1874, from the designs of Mr. A. C. Kirk, now of the firm of Messrs. R. Napier & Sons, for the S.S. *Propontis.* The next triple-expansion engines were those of the yacht *Isa,* of Newcastle-on-Tyne, in 1877, steam-power 120 lbs. In 1881 the *Aberdeen* was built and fitted with triple-expansion engines by Messrs. R. Napier & Sons, the steam pressure being 125 lbs. In the *Propontis* and *Aberdeen* there were three cranks, in the *Isa* two cranks only, two of the cylinders being arranged tandem-wise. The diameters of the *Aberdeen's* cylinders are 30, 45, and 70 inches respectively, with 4 feet 6 inch stroke." Since then many sets of such engines have been made, the steam pressure rising to 160 and 170 lbs. A few quadruple-expansion engines have also been made.

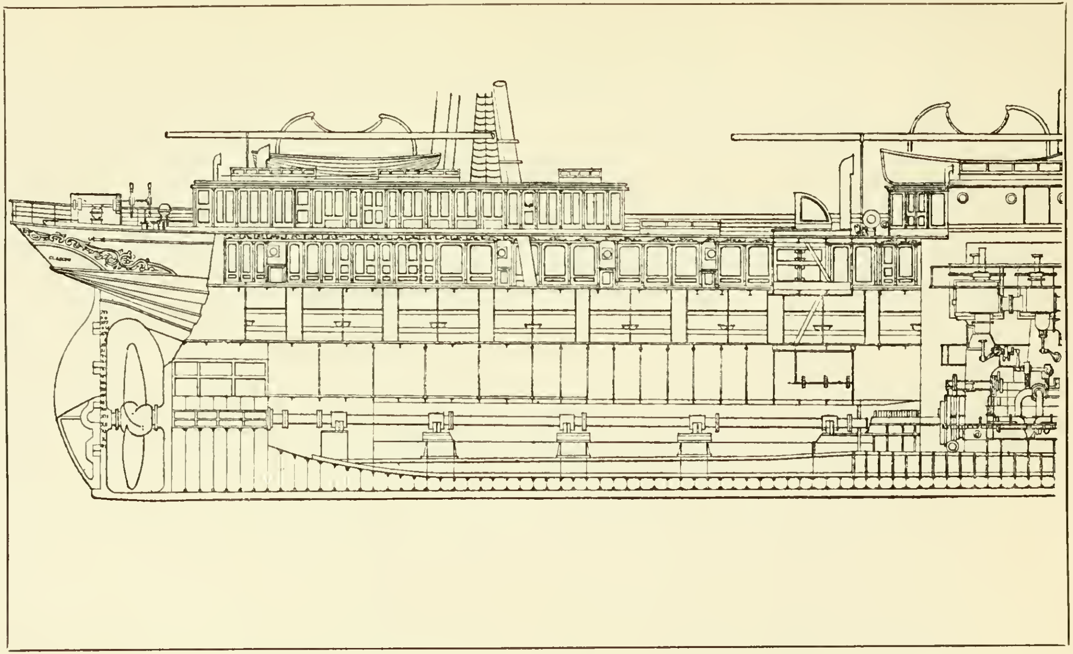
[1] See *Trans. Inst. Naval Architects* for 1887.



The Industry in Bowling Harbour (the oldest steamer in the world).



Longitudinal Section through Engine and Boiler Rooms of an Ocean-going Steamship.



Longitudinal Section through after-part of an Ocean-going Steamship, showing Propeller and Shafting.

PROGRESS OF SHIPPING.

There are many lines of steam vessels now sailing from the Clyde to various parts of the world.

The total number of ships which have carried the flag of the old firm of G. & J. Burns, started in 1824, together with that in the new Cunard Co., started in 1840, reaches to 186 vessels, divided as follows:—

Route.	Vessels.	Tonnage.
Glasgow and Belfast and North of Ireland,	47	24,548
Glasgow and Liverpool,	35	20,734
Glasgow and the Highlands,	15	1,651
Glasgow and Firth of Clyde,	11	2,085
Liverpool and America,	59	163,513
Mediterranean and Havre,	19	25,769
	186	238,300

The nominal horse-power of these vessels reaches to 55,055.

The years in which these various routes were started are: Glasgow and Belfast, 1824; Glasgow and Liverpool, 1828; Glasgow and the Highlands, 1832; Liverpool and America, 1840; Glasgow and the Firth of Clyde, 1846; Liverpool and the Mediterranean, 1853.

As it is interesting to know something of the origin of such widely-spreading and successful undertakings, so is it also desirable to have some idea of what the first vessels were like with which the various routes were opened. The first steamer on the Glasgow and Belfast route belonging to Messrs. G. & J. Burns was the *Fingal*, a wooden paddle steamer of 296 tons and 100 horse-power. The powerful steamers for the Belfast service, built and

engined for the firm by Messrs Barclay, Curle, & Co. a few years ago, measure 250 feet in length by 30 feet in breadth and 14 feet 7 inches deep. The speed is 15 knots, the average passage from Greenock to Belfast being 7 hours. Between Glasgow and Liverpool there was the *Glasgow,* a wooden paddle steamer of 280 tons and 100 horse-power, built by John Wood, Port-Glasgow, engined by Caird & Co., Greenock, with side-lever engines, the steam pressure being only 5 lbs. per square inch. Plying between Glasgow and the Highlands was the *Staffa,* a wooden paddle steamer of 60 tons and 45 horse-power, and between Liverpool and New York, the *Britannia,* a wooden paddle steamer of 1154 tons and 440 horse-power. This early ocean steamer was only 207 feet long (about the length of an ordinary Clyde passenger steamer of the present day), 34 feet broad, and 22 feet deep, fitted with side-lever engines. Her speed was about 8½ knots. Sailing between Glasgow and the coast, the *Dunoon Castle,* a wooden paddle steamer of 190 tons and 50 horse-power; and between Liverpool and the Mediterranean ports, the *Taurus,* an iron screw steamer of 1126 tons and 180 horse-power (nominal). The *Britannia* was built at Greenock in 1840 by R. Duncan and Co.; the engines were by R. Napier. The dimensions were: length, 207 feet; breadth, 34 feet; depth, 22 feet; gross tonnage, 1155. There were two side-lever engines, the diameter of the cylinders being 72 inches, with a stroke of 6 feet 10 inches. The power was 403 nominal, and the speed about 8½ knots. The *Persia* was built in 1856 for the Cunard Co. by R. Napier & Sons at Glasgow. Dimensions: Length, 375 feet; breadth, 46 feet; tonnage, 3590; 850 nominal

horse-power, or about 3600 actual; side-lever engines; speed, about 13 knots, and time of passage between Liverpool and New York, 10½ days; coal burned per day, 150 tons. The *Scotia*, built in 1862, was the last large paddle steamer belonging to this company.

The "Allan Line," now possessing a large and well-appointed fleet of Atlantic steamers, may be said to have originated three-quarters of a century ago, when the founder of the line, Alexander Allan, owned and commanded a ship carrying stores to the Peninsula during the old wars. Afterwards he traded regularly between the Clyde and Canada. In 1820 the Allan Line of sailing ships was established, and thus formed that link between the Scottish river and that other great river the St. Lawrence which has been continued unbroken to the present day. In 1853 the first steamer of this line, the *Canadian*, was built at Dumbarton by Messrs. Denny, the dimensions being: length, 277 feet; breadth, 33 feet 8 inches; depth, 23 feet 9 inches; tonnage, 1765. The Canadian mail service was begun in the same year, the vessels sailing from Liverpool. The steam service between Glasgow, Quebec, and Montreal was started in 1862. In 1871 the company ran vessels between Liverpool and St. John's, Newfoundland, Halifax, and Baltimore.

Glasgow to Boston in 1879.
„ to Halifax in 1879.
„ to Philadelphia in 1884.
„ to Monte Video and Buenos Ayres in 1876.
Havre to „ „ „ „ in 1876.
Liverpool to „ „ „ „ in 1878.
London to Quebec and Montreal in 1884.

The Allan Line have a goodly record of ships, the roll from the commencement consisting of

				Tonnage.
Sailing ships	Built of wood,	30		
	„ of iron,	16		
		—	46	43,234
Steamers	Built of iron,	48		
	„ of steel,	7		
		—	55	146,432
	Total,		101	189,666

These vessels, representing as they do an investment of about four millions sterling, will convey some idea of the importance of this company. In the year 1881 the *Parisian* was added to the fleet, built and engined by Messrs. R. Napier & Sons. This vessel is of steel, her dimensions being: length, 440 feet; breadth, 46 feet; depth, 33 feet; tonnage, 5366. The first steel steamer of this line, the *Buenos Ayrean,* was built in 1879 by Messrs. Denny of Dumbarton, 4004 tons register. This vessel indeed was the first large ocean-going steamer built of steel, which, as a comparatively new material for ship-building, had still to prove its reliability and efficiency. At the present time (1887) the Allan Line fleet consists of

12 iron sailing ships of	18,120	tons.
and 31 steamships (24 of iron and 7 of steel),	96,222	„
Having a total tonnage of	114,342	tons.

The collective nominal horse-power of the steam fleet is about 12,530, or equivalent in these days of great pressure and high piston speed to about 50,000 indicated horse-power.

The Anchor Line was started in 1856 by Messrs.

Handyside & Henderson of Glasgow, the Mediterranean being their first special field. In 1863, however, they commenced the Glasgow and New York service, the *Caledonia* and *Britannia* being their first steamers on this route; and since then their flag, with its emblem of hope emblazoned, has waved from many a tall mast in their fleet, their right to their adopted motto, "Secure amid perils," having been well-earned through the safe and efficient service which they have now established on the ocean. The Mediterranean trade commenced in 1854 with the *Vasco de Gama*, bringing from the sunny shores of the great inland sea oranges, raisins, lemons, &c. The Atlantic service commenced in 1857 with the *Tempest*, 844 tons. The Indian service commenced in 1875 with the *Caledonia*, of 2145 tons.

Besides owning a fleet of steamers, the firm carry on extensive ship-building and engineering works at Glasgow.

Since its commencement the company has had close on 100 vessels, having a collective tonnage of 159,000 tons. Forty-three of these comprise the existing fleet, with a total tonnage of 117,000 tons. Of these the *Furnessia* is the largest vessel sailing from the Clyde, being 445 feet in length by 44 feet beam, and 34 feet deep; tonnage, 5494 tons.

The building of sailing ships still continues to be carried on to a large extent notwithstanding the progress of steam; and one can frequently see some great "four master" getting fitted with hollow iron masts, wire-rope standing rigging and running tackle, with yards and sails, double topsails, and what not.

The sailing ship, both as a line packet and a China clipper, is largely a thing of the past; but still the demand for sailing vessels for certain routes continues. The races of the old China clippers were exciting events, these vessels often leaving with their cargoes of tea about the same time, and thereafter traversing the many thousand miles of their course, only again sighting each other as they approached the English Channel. As many famous ships of this class were built on the Clyde, and owned by merchants there, it may be of interest to state that the *Sir Lancelot,* which was built by Messrs. Steele at Greenock, and owned there by Mr. John MacCunn, made the passage in 1869 from Foochow to London in 89 days, averaging, during many days, fully 300 miles per day.

Mr. Thomas Gray, C.B., of the Board of Trade, in an interesting address on the maritime legislation of the last fifty years, delivered before the members of the Shipwrights' Company, London, gives a number of interesting details, some of which may not be unfitly referred to in a work on the river Clyde, more especially as he refers to that river several times in the course of his remarks. Speaking of the great development of the shipping interest, he says: "In 1836 there were 25,820 ships on the register of British ships, and their tonnage was 2,792,646 tons. Of these ships 600 were steamers of 67,969 tons." "In 1886 there were 38,335 ships on the register of British ships, and their tonnage was 9,323,615 tons. Of these ships 8913 were steamers of 4,293,115 tons. Comparing the effective tonnage by assuming that one steam ton does four times the

work of one sailing ton, Mr. Gray concludes "that while in 1836 (taking the work done by a sailing ton as the unit) there were 2,996,553 effective tons of shipping, there were in 1886 22,202,960 tons." In speaking of our ships, he says: "Before 1836 British ships were chiefly built of wood, and were chiefly sailing ships; and naval architecture had received no adequate attention in this country, the tonnage law being much to blame for this; but since the tonnage law of 1854 was passed, and the improvements effected by the skill of naval architects, and classification, the models of ships have now been brought to much perfection."

In speaking of seamen, Mr. Gray, says: "British seamen are now divided into five distinct classes, and the division between men in each of those classes is broadening and becoming marked every day. Now the navy trains its own men, and is the most popular branch of the national services." Fishermen have now become a separate class. Firemen, stokers, &c., form the third; the fourth is the British mercantile Jack; the fifth Asiatics and others, but British subjects. Mr. Gray does not recognize the foreign seamen as a separate class. The naval reserve numbers 18,000 men, nearly the half of whom are fishermen. Mr. Gray, in speaking of the improvement in our seaman, says: "I have to put this to his credit, that he deposits in the savings-bank at the rate of £70,000 a year."

THE SITUATION FIFTY YEARS AGO.

As regards 1836 I must ask you to picture to yourselves a time of which the records are as follows, viz.:—

When British ships were classed by Lloyd's solely on age, or according to port of building:

When protection of British shipping existed as against foreign ships, and when British Colonial ships were excluded from many foreign ports, and others were admitted only on paying a *surtax de pavillon:*

When British ships were so faulty in design, and as sailers so slow, that British shipowners feared free-trade, because they knew that successful competition on equal terms with foreign ships was impossible:

When trading harbours were so shallow that the bottoms of ships needed to be specially constructed to take the ground:

When, in spite of the fact that some of the officers of the larger foreign-going ships were gentlemen of the highest attainments and of undoubted reputation, drunkenness and incompetency among the ordinary run of officers, as well as of seamen, was notorious:

When charts were notoriously inefficient:

When lifeboat and rocket apparatus were not stationed around our coasts:

When the mercantile marine largely depended for a supply of seamen on pauper apprentices:

When there was no examination of masters, mates, and engineers:

When numerous lighthouses were the property of, or leased to, individuals for their personal benefit, and when surplus light dues went to so-called charitable purposes, and to other purposes unconnected with shipping:

When harbour dues, town dues, charity dues, and passing dues were levied on ships, and were also frequently appropriated to many purposes not solely connected with shipping:

When there were no harbours which would now be called harbours of refuge, though a passing toll had to be paid by all ships passing Whitby, Bridlington, Dover, or Ramsgate:

When there were scarcely any docks:

When the Clyde, Tyne, and Tees were navigable only by small vessels even at high water, and many other ports now flourishing scarcely existed:

When freight was the mother of wages:

When payment for salvage of life was unknown:

When ships did not carry side-lights:

When there was no international rule of the road at sea:

When no reports of wrecks were required to be made:

When no inquiries as to wrecks were held:

When the press-gang was in full work:

When crimps preyed, and preyed unchecked, on British seamen:

When there were no savings-banks nor seamen's money order system:

When there was no system for recovering the wages and effects of deceased seamen:

When the only seamen available for augmenting the navy in emergency consisted of undrilled men of the mercantile marine:

When there was no statutory provision as to the supply of food or as to the accommodation of seamen:

When there were no checks to the tyranny of masters and mates at sea; no provision for the proper execution and enforcement of contracts between masters and seamen: no naval courts, &c.:

When one ship was not required to stand by another ship after collision:

When a seaman could not raise any question as to the unseaworthiness of his ship, but could be sent to prison as a deserter if he went ashore to complain:

When there was no international or commercial code of signals:

It is possible that but few shipowners of the present day, especially those who now feel inclined to complain of what they are pleased to call "government coddling" of seamen, can bring themselves to realize such a state of things—it is within the range of possibility that some of them never even heard of it. Yet that was the state of things fifty years ago, and these were the features of the so-called "good old times" whose departure, especially as regards seamen, they profess to deplore.

The following advertisements of some of the early steamers are taken from a sketch of the history of the Anchor Line, published in 1872. In connection with these early records it may be observed that the present year has a special significance in connection with the use of steam as a means of propulsion, as it is just one

hundred years since Patrick Miller's experiments were made on Dalswinton Loch. Again, it is just fifty years since the first steam-vessel crossed from this country to America. The year 1888 is therefore the centenary of steam propulsion, and the jubilee of ocean navigation by steam-ships. As early, however, as 1819, a vessel called the *Savannah* was built in New York. She was of 300 tons burden, ship-rigged (three masts); had one inclined direct-acting engine; cylinder, 40 inches diameter; 6-feet stroke; 20 lbs. steam; paddles of wrought iron, without paddle-boxes, and which, it is said, could be removed and shipped on deck in about 20 minutes. She sailed from New York to Savannah on 28th March, 1819. The following advertisement appeared in a paper of the time, notifying her return voyage to New York:—

"PASSAGE TO NEW YORK.

"The steam-ship *Savannah*, Captain Rogers, will make one trip to New York, previous to her departure for Liverpool, should a sufficient number of passengers offer, and will be ready to proceed in the course of this week or commencement of the next. Apply on board at Taylor's Wharf, or to Scarbrough & M'Kinne."

The following advertisment appeared on the 19th May, 1819, intimating her voyage to Liverpool:—

"FOR LIVERPOOL.

"The steam-ship *Savannah*, Captain Rogers, will, without fail, proceed for Liverpool direct, to-morrow, 20th inst. Passengers, if any offer, can be well accommodated. Apply on board."

Apparently the public of those days had no confidence in this new and untried method of propulsion, as no

passengers came forward. The vessel, however, set sail for Liverpool on the 20th May, and arrived at that port on 20th June. The engine was worked for 18 days of the passage; pitch-pine was used instead of coal. The *Savannah* then boldly set sail for St. Petersburg, and returned to her native American shore again all safe after a successful voyage of 50 days from St. Petersburg.

Some time after her return the machinery was taken out, and as a sailing vessel only she traded on the American coast, until lost in a storm on Long Island.

In 1825, *The Enterprise*, of 500 tons, and 120 horse-power, made the passage to India. The *Enterprise* was built on the Thames by Messrs. Gordons & Co., and launched on 22d January, 1825. She had two engines of 60 horse-power each made by Henry Maudslay. After a long and troublesome passage round the Cape of Good Hope, as the Suez Canal was not even thought of in those days, she reached Madras, having had to depend on her sail power for a considerable part of the passage.

The *Sirius* was built by Mr. Menzies of Leith, the engines and boilers being made by Mr. T. Wingate of Glasgow. The dimensions of this vessel were as follows: length, 178 feet 4 inches; beam, 25 feet 8 inches; depth, 18 feet 3 inches; register tonnage, 412. There were two side-lever engines of 270 horse-power; and as a notable feature in these early days, she had a surface-condenser. The cylinders were 60 inches diameter with a 6-foot stroke. The paddle-wheels were 24 feet 1 inch in diameter, having 22 floats, each 9 feet 6 inches long by 2 feet 6 inches broad. The *Sirius* left Cork for New York on 5th April, 1838, and arrived after a passage of 18½ days.

The advertisement of her return voyage reads as follows:

"British Steam-packet Ship for London, to sail from New York, May 1, 1838.

"The New and Powerful Steam-ship *Sirius*, 700 Tons Burthen and 320 Horse-Power, Lieutenant R. Roberts, Commander,

"Is intended to sail from London, March 28th, touching at Cork, and thence, on 2nd of April, for this port, returning from New York to London on the 1st of May. This vessel has superior accommodation, and is fitted with separate cabins for the accommodation of families, to whom every possible attention will be given. Cabin, $140, including provisions, wines, &c. Second cabin, $80, including provisions. This superior steam-ship has been chartered by the directors of the British and American Steam Navigation Company, of London, to meet the pressing demands of the public, in anticipation of the steam-ship *British Queen*, now building,—is a new vessel, about six months old, and has proved herself superior to any steam-vessel in British waters in speed and seaworthy qualities. Further information afforded on application; and, for freight and passage, apply to Wadsworth & Smith, 4 Jones Lane (rear 103 Front Street), agents of the British and American Steam Navigation Company."

The *Great Western* was built by Mr. Paterson of Bristol, and engined by Maudslay of London. She was 212 feet in length, and had engines of 440 horse-power. This vessel left Bristol on the 8th of April, arriving in New York after a passage of 14½ days. The *Sirius* arrived at New York on the morning of the 23d of April, and the *Great Western* on the afternoon of the same day. The arrival of these vessels caused great excitement in New York.

The Great Western Steamship Company afterwards added the *Great Britain*. The *British Queen* was built

at London and engined by Robert Napier. She left Portsmouth on 12th July, 1839, and arrived at New York after a passage of nearly 15 days. The *President*, a later steamer, on her return voyage from New York to Liverpool in 1841, was never afterwards heard of. The *Royal William* was the first steamer to cross the Atlantic from Liverpool. She was 617 tons burthen and 276 horse-power. She sailed for New York on 5th July, 1838, arriving 19 days later, and returned on the 4th August of the same year. The following announcement being made in the New York papers:—

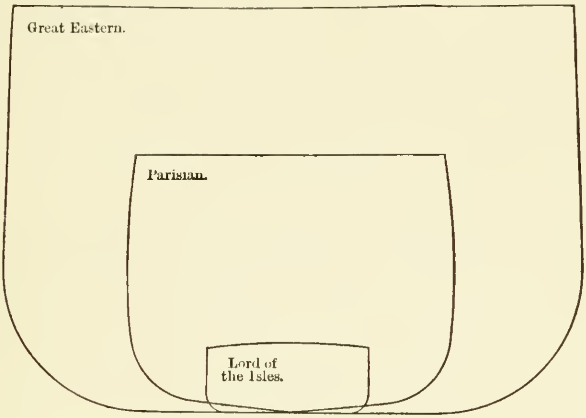
"British Steam-ship, *Royal William*, 617 Tons. Captain Swainson, R.N., Commander.

"This fine steamer, having lately arrived, will be dispatched again for Liverpool on Saturday, 4th August, at 4 p.m. She is only 16 months old, and from her peculiar construction, being divided into five sections, each water-tight, she is considered one of the safest boats in England. Her accommodations are capacious and well arranged for comfort. The price of passage is fixed at $140, for which wines and stores of all kinds will be furnished. Letters will be taken at the rate of 25 cents for the single sheet, and in proportion for larger ones, or one dollar per ounce weight.

"For further particulars, apply to Abraham Bell & Co.; or, Jacob Harvey, 28 Pine Street."

A vessel also named the *Royal William* was built at Three Rivers, near Quebec, in 1831. She was 160 feet long by 44 feet broad, and 17 feet 9 inches deep, and of 363 tons register. She crossed to Liverpool in 1833, and was afterwards sold to the Spanish government for a war vessel, and said to be the first steam-vessel so employed. Great changes in the forms and dimensions of

steam-vessels have taken place during the period of now fully three quarters of a century since the *Comet* was launched. The annexed diagram shows the comparative sizes of some of the leading steamers of this period. The



Comparative Sections of Three Steamers.

Great Eastern, although now nearly approached in length by the Atlantic liners of the present day, is still a long way in excess of these in tonnage room, and displacement. The annexed diagram shows the comparative midship sections of the *Great Eastern,* a 5000-ton steamer, and a river steamer.

The ship-building industry of the Clyde is naturally of older date on the lower reaches of the river, as until somewhat recent times the Clyde from Glasgow for many miles down was too shallow to admit of the passage of vessels of large dimensions.

It appears[1] that the first square-rigged vessel, a brig built at Greenock, was launched in 1760. In the year 1776 the largest vessel built there was only 77 tons. There were larger vessels, however, than this frequenting the harbour of Greenock, some being of 250 tons. These, however, were chiefly built in the colonies, and were owned in Glasgow. A stimulus, however, was given to the Greenock building trade, both from the demands for larger vessels and from the fact that the American colonial vessels, although cheaper than those made at home, were deficient in durability.

The introduction of steam as a propelling power, in the beginning of the present century, gave a great stimulus to Clyde ship-building, and by degrees the river banks have had yard after yard added, until at the present time, from the lower part of the Glasgow harbour, the building yards are met with on each side extending for several miles, and thereafter at Paisley, Bowling, Dumbarton, Port-Glasgow, and Greenock. Again, along the shores of the Firth there are other ship-building yards, amongst which may be noted the old yacht-building centre at Fairlie.

Several of the ship-building firms on the river have existed under the same names or with slight variations during a long period of years, that of Barclay, Curle, & Co. being apparently the oldest—the business having been commenced at Stobcross in 1822.

Iron and steel has now replaced wood for the construction of large vessels. The tonnage launched on the Clyde in 1864 was 178,505 tons, and in 1883 404,383

[1] *Memorials of James Watt.*

tons.[1] Since this latter date the general depression of trade has largely affected the ship-building industry both here and elsewhere.

The following extract from *Barker's Trade and Finance Journal* shows very clearly the relations of the ship-building trade at home and abroad:—

"It is satisfactory to know that in ship-building the United Kingdom continues to maintain a supremacy which is unquestioned. We do sometimes hear of foreign competition in this as in other branches of business, but the marvel is that we are able to keep such an enormous lead as we do. The facts are astounding. Out of a total of 404,016 tons registered by the United Kingdom, France, Germany, Italy, Norway, and Sweden, during the year 1886–7, 327,743 tons were built in the United Kingdom and 76,273 tons were built elsewhere; but out of these 76,273 tons no less than 19,916 tons were wood or composite, leaving only 56,357 tons of iron or steel vessels built out of, as against 327,743 built in, the United Kingdom. Germany and France are the only countries which produce any appreciable quantity of iron or steel tonnage, although Sweden and Norway produce what little they require for their own use. Germany is fast becoming a ship-building country, already producing two-thirds of her fairly large requirements; and France produces less than two-thirds of her requirements, although these are less than one-third of Germany. No country in the world, excepting the United Kingdom, is at present able to supply a market outside of itself. Therefore, with the

[1] *Vital, Social, and Economic Statistics of the City of Glasgow.* By James Nicol, City Chamberlain.

exception of the four countries named, the whole world is dependent upon the ship-building yards of this country for its fleets. We have only been able to maintain this supremacy by keeping well to the front in all improvements. To the enterprise and business ability of its ship-owners and ship-builders this country owes much. There does not appear to be any likelihood that they will lag behind in the future. One illustration will show how they are taking the lead now. In the building of ships, as in many other directions where iron has been largely used, the merits of steel, as compared with iron, is one of the most important questions of the day, and is being undoubtedly settled in favour of steel. Figures clearly show that we are not slow to adopt improvements, but rather that we are much more ready than the rest of the world to do so. While we have practically ceased the building of wood and composite vessels, more than one-half of the total built elsewhere are still of these obsolete types, and iron vessels are nearly as two to one of steel, whereas we are building considerably more of steel than of iron."

Ship-building, like marine engineering, has now become a science as well as an art, and one of the recent chairs founded in Glasgow University is for the study of the principles on which these important branches of our industrial activity depends. The naval architect deals with such matters as form and stability, and is conversant with such terms as metacentres, centres of buoyancy, moments of stability, &c. The ship-builder, whether working in wood, iron, or steel, has a definite series of practical considerations before his mind both of a con-

structive and commercial character from the time the keel is laid till the launching of the vessel.

In the building yards in the old days of the "wooden walls,"

> "Covering many a rood of ground,
> Lay the timber piled around;
> Timber of chestnut, and elm, and oak,
> And scattered here and there, with these,
> The knarred and crooked cedar knees."

Now in our great building yards it is iron and steel frames and plates which cover the ground, and the sound of the "busy hammers closing rivets up" is heard on all sides.

The following are some of the leading steps in the building of an iron or steel ship:—

1st. General design, including tonnage, speed, engine power, draught of water, stability, &c.

2d. The keel. Logs are laid along the ground, and on these blocks are placed at an inclination of about one in twenty towards the water. The keel is laid along these blocks.

3d. The frames are composed of angle iron or steel. They are bent to the required curves and riveted together, so as to form a Z section.

4th. The beams for supporting the decks are formed of T section, iron or steel. The frames are now put into place on the keel, and the beams attached to them. The frames are then "faired" and the keelsons fitted.

5th. The plating is now put on, each plate being cut to the proper size, and the rivet holes made. It is rolled so as to fit the shape of the part of the vessel it is to

occupy. It is then taken to the ship, and riveting begins. The butts and edges of the plating are then caulked water-tight by forcing the one edge close to the other. The internal fittings are in the meantime being carried on.

But although it is of first importance that the various building operations shall be successfully carried out, yet unless suitable provision be made for getting the completed vessel into the water the labour would be thrown away, or, as in the case of the launching of the *Great Eastern,* a long period of time might elapse and expense be incurred before this was accomplished. The launching of a ship, especially of such vessels as are now built for our ocean lines, is therefore a matter of great importance, and has to be carefully considered. Generally speaking the various steps are as follows: The vessel having been built resting on the keel-blocks, ways are laid down on each side, and a timber structure called a cradle formed around the under part of the vessel. The cradle rests on the ways. The ways are inclined with slopes varying according to circumstances.

Prior to the launch these ways are coated with grease, and the cradle allowed to rest upon them; the keel-blocks are then removed, and the vessel allowed to rest completely on the cradle, the latter being kept from sliding downwards by a movable piece of wood called a dagger, which is knocked out of its place by a heavy weight allowed to fall at the moment of launching by the cutting of a cord, usually assigned to a lady visitor.

Besides the harbour and dock works at Glasgow already referred to, there are other public and private docks on

the line of the river, such as at Bowling, Dumbarton, Port-Glasgow, and Greenock.

The harbour works at Greenock are now distinguished as the old and new works.

The West Harbour, commenced 1707, has a water area of 7½ acres, with a public graving-dock 220 ft. long, with about 10 ft. depth on sill. The East India Harbour, commenced 1805, water area 6¾ acres. A public graving-dock is connected with this harbour, 356 ft. in length, depth on sill about 12 ft. The Victoria Harbour, commenced in 1846, water area 5½ acres, length 560 ft., width of entrance 150 ft., depth at low water 14 ft. The Albert Harbour, commenced 1862, water area 10¾ acres, length 1000 ft., width of entrance 100 ft., depth at low water 14 ft. In the construction of the Albert Harbour a new system of working without coffer-dams was introduced by the engineers Messrs. Bell & Miller, C.E., of Glasgow. The method adopted was to "form the walls under low water of a combination of cast-iron guide-piles in the front, with a continuous stone-facing slid down over and inclosing these, and of concrete backing deposited in a soft state;" timber bearing piles being used where required, the walls from the low-water line being carried up of masonry. The ground was found to be unequal, the upper being mud and sand, further down red "till." The concrete employed was formed of Arden hydraulic lime (a useful material obtained to the south of Glasgow), iron-mine dust, sand, gravel, and stone chips.[1]

The new works wholly or partly completed, comprise: The Garvel Basin, area 6 acres, width of entrance 175 ft.,

[1] *Structures in the Sea.* By Daniel Miller, M.Inst.C.E.

depth at low water 25 ft. The Great Harbour, area 45 acres, depth at low water 28 ft. The James Watt Wet Dock, water area 14 acres: two entrances of 75 ft. each, depth on sills 32 ft. Garvel Graving Dock, 635 ft. in length, width of entrance 60 feet 6 inches, depth on sill 20 feet.

From the *Annual Report of the Clyde Trustees* for the year ending June, 1887, it appears that the total imports at Glasgow from foreign ports was 1,160,598 tons; coastwise, 648,010 tons; whilst the exports during the same time were: to foreign ports 1,202,276 tons, and coastwise 712,174 tons.

The goods imported consist mainly of

Iron Ore, ...	374,000 tons.
Flour, ...	209,000 „
Indian Corn, ...	154,000 „
Timber, ...	88,000 „
Wheat,...	71,000 „
Sugar, ...	42,000 „

Amongst other goods imported we find:

Pyrites, ...	39,957 tons.
Barley, ...	28,929 „
Pease, ...	28,380 „
Fruits, ...	19,989 „
Oats, ...	14,468 „
Oil, ...	14,289 „
Bales and boxes of goods, ...	11,777 „
Bacon, ...	10,908 „
Rosin, ...	10,226 „

Of goods exported coal, iron, and machinery have the chief place. Thus—

Coal totals up to about	830,000	tons.
Pig iron, ...	190,000	„
Iron bars, rods, rivets, rails, &c.,	121,000	„
Cast-iron pipes, ...	98,000	„
Other castings, ...	47,000	„
Bales and boxes of goods, ...	120,000	„
Steel, nearly	50,000	„
Machinery, ...	51,000	„
Beer and spirits,...	51,000	„

Amongst other articles exported from Glasgow were the following:—

Bricks, ...	22,456	tons.
Spirits, ...	12,503	„
Timber, ...	12,336	„
Chemical manure, ...	8,480	„
Coke, ...	8,344	„
Coal-tar pitch, ...	7,983	„
Oil (Crude Shale), ...	7,153	„
Paper materials, ...	5,688	„
Earthenware, ...	5,121	„
Paints, ...	3,556	„

The annual revenue of the Clyde Trust in ten-year periods, from 1787, is as follows:—

1787	£1,975
1797	3,182
1807	5,000
1817	7,028
1827	14,316
1837	37,644
1847	59,017
1857	82,797
1867	131,892
1877	208,732
1887	287,933

From 1752 to 1770 it was only £147, in 1771 it was £1044, and the total revenue to 1887 is £7,167,281. This revenue was mainly derived from dues on vessels and on goods. The annual revenue and tonnage of the ports on the river appear to be as follows:[1]—

Clyde Navigation Trust, ...	£287,933
Greenock Harbour Trust, ...	54,859
Port-Glasgow Harbour Trust, ...	4,868

		Tons.
Register tonnage	inwards at Glasgow, ...	1,026,279
,,	outwards ,, ...	1,430,736
,,	inwards at Greenock, ...	231,705
,,	outwards ,, ...	97,510
,,	inwards at Port-Glasgow,	69,000

The revenue of the Clyde Lighthouse Trust appears to be £12,670.

Measured miles[2] have been laid off at Skelmorlie and in the Gareloch, where trials of the speeds of vessels can be made, the time being taken as the steamer passes the extremities of the measured distance, which are marked by two tall posts. It is also customary to test the speed by running the lights, or taking the time occupied on the run between the Cloch and Cumbrae Lighthouses; this distance is 13·666 knots, or 15·736 statute miles. Buoys for compass adjustment are laid down in the Gareloch.

The question of the relation existing between speed and resistance has of late years been ably investigated

[1] *Alliance of Clyde Ports, 1888.*

[2] This measured mile is a nautical mile or knot, which bears to the statute mile a ratio of 1·1508 to 1, or roughly one-seventh longer.

both experimentally and mathematically, amongst others by the late Dr. Froude of Torquay, and by two well-known Clyde ship-builders, Mr. Robert Mansel and the late Mr. William Denny. Dr. Froude's experiments were carried out in a large tank 270 feet long by 36 feet broad and 10 feet deep, containing suitable mechanism for moving the models. These latter varied in size from 6 feet to 20 feet, and were made of paraffin.

Messrs. Denny, at their ship-building works at Dumbarton, have constructed a large tank for the same purpose, with special machinery for recording the results obtained, and also for making the models.

The principal elements of ship resistance, as determined by Dr. Froude, consisted in frictional resistance of the skin of the ship, eddy resistance, and wave-making resistance. The first is the most important in a well-formed ship, and appears to vary as the 1·87th power of the speed. The relation between power and resistance has been expressed by the old admiralty formula as $C = \frac{MV^3}{E}$, in which M is the immerged midship area, E the gross indicated horse-power, V speed in nautical miles, C being a numerical coefficient, and which is to a certain extent the measure of the efficiency. Great variations in the value of the coefficient are found at different speeds.

Much useful information as to power and speed has been derived from progressive speed trials, due largely to the labours of the late Mr. Wm. Denny, and from diagrams constructed of the results obtained. Thus, if the speeds are set off to scale on a horizontal line, and the corresponding power required to drive the ship sets off

as verticals, the curved line joining the upper ends of these vertical lines will show the relation between the speed and power. Mr. Mansel, in analysing these relations, takes the logarithms of the ratios of the different powers and speeds, and uses these for the verticals raised at the corresponding speeds, the result being that the relation between these verticals and the horizontal distances is now shown by a straight line more or less inclined.

Mr. Mansel, in treating of this subject, says: "In a given steam-vessel under experiment, if we carefully measure various rates of development of the power, and note for each the corresponding rate of speed of the vessel, the normal law of the relation of these elements, power and speed, can be stated thus:—The logarithms of the ratio of the power to the speed, drawn as ordinates to the speed laid off as abscissæs, will range in a straight line inclined to the axis."

In a paper read before the Greenock Philosophical Society in 1882, on "The Speed and Carrying of Screw Steamers," the late Mr. Wm. Denny explains in a very lucid manner the law of comparison between the ship and model. He says: "What Mr. Froude discovered amounts to this—that for vessels of the same proportionate dimensions, and of the same form, or, as we say, of the same lines, there are speeds appropriate to these vessels which vary as the square root of the ratio of their dimensions, and that at these appropriate speeds the resistance will vary as the cubes of these dimensions." He then goes on to illustrate this, and takes the case of two steamers, the linear dimensions of one of which are

four times greater than the linear dimensions of the other. Thus if the length of the first is taken as 400 feet the length of the other is taken at 100 feet, the breadth of the first being 40 feet that of the second is 10 feet, and if the draft of water of the first steamer is fixed at 20 feet the second will be 5 feet; the appropriate speed for these vessels will therefore be $\sqrt[2]{\frac{D}{d}} = \sqrt[2]{\frac{4}{1}} = \frac{2}{1}$, that is, the speed of the larger vessel should be twice the speed of the small vessel. And so Mr. Denny says: "What Mr. Froude would have predicted of these two steamers is—that if the speed of the smaller steamer were 10 knots, then the similar appropriate speed of the larger steamer would be 20 knots." At these speeds Mr. Froude proved that the resistance, with some allowance, would be as the cube of the steamer's dimensions, which would give for comparative resistance with these figures, as $\left(\frac{D}{d}\right)^3 = \left(\frac{4}{1}\right)^3 = \frac{64}{1}$ or as 64 is to 1.

This, as Mr. Denny points out, "means practically that the resistance would vary as the displacement of the two steamers;" so that, in the case illustrated, the speed is doubled without adding to the resistance per ton of weight, and that consequently at a lower speed the large steamer would have a very much less comparative resistance; hence, "in the same type of steamer, by simply increasing all the dimensions proportionately, the same speed can be obtained with much less resistance per ton of weight driven through the water—that is, since the speed remains unchanged, much less expenditure of horse-power, and consequently much less expenditure of coal per ton of weight driven."

The relation of the powers required to drive the ship and model can also be shown by another power of the ratio of the lineal dimensions, viz.: $\frac{P}{p} = \left(\frac{D}{d}\right)^{\frac{7}{2}}$, where P and p are the powers required for the ship and model respectively.

These powers are the effective powers required to overcome the fluid resistance. The gross power is much in excess of this, as there are losses by friction of the working parts. Dr. Froude found that the thrust or effective power is $37\frac{1}{2}$ per cent of the indicated power.

Chapter VII.—COMMERCIAL AND INDUSTRIAL.

Much has been written and spoken in connection with the Union of 1707, in respect to its effect on the industrial condition of Scotland, and more especially with reference to the rise and progress of the commercial life of Glasgow. The union of the crowns, in 1603, was one of inheritance on the part of the Scottish king, but this was not necessarily, as the event proved, of special advantage to Scotland; and it was not until many changes had taken place that the treaty, whereby a legislative union was established, removed certain restrictions on the foreign trade which enabled the Scottish merchants —more especially on the west coast—to open up enterprises which formerly had been closed to them. But, after all, what could have been expected in the way of commercial operations in the earlier times? The country had been for centuries in a state of turmoil; a condition

of things which is prejudicial to that peace, security, and recognition of law which encourages and gives confidence to commercial undertakings.

After the death of Alexander III., throughout whose reign the country was becoming consolidated after the earlier struggles, a long period of turmoil arose during the contention for the crown and the armed interference of the English monarch, Edward I. The Scottish nation, without a king to lead them, found in the patriot hero Wallace one who carried on the cause of national liberty boldly and unselfishly for several years. Then it was taken up by the Bruce himself, who fought against the power of both the first and second Edwards, finally rolling back the tide of usurpation on the field of Bannockburn.

During the next two centuries we read in history of almost nothing but war and turmoil, Scotch and English invading each other's country, and fighting desperately with equal courage and valour. In James IV.'s reign we find that not only on land, but also at sea, the old fighting was kept up; and it says a great deal for the resources of the country at that time, and for the skill of the east-coast ship-builders, that they could turn out such ships as enabled Sir Andrew Wood successfully to cope with the English vessels.

The great nobles and the monarch watched each other, trying who was the stronger. Sometimes the former had the advantage, and laid hands on royalty itself. Another half-century, and the career of the unfortunate Mary ended. The Reformation, both in Scotland and England, had taken place. Knox, with an early enlighten-

ment in scholastic matters, endeavoured to provide in a systematic manner for the welfare of the people, by founding schools, and establishing the means for a proper religious training; but political contention was now for a time united with religious zeal, and, in the earlier part of the reign of James VI., the country was in a state of civil war. In 1603 that monarch succeeded to the English crown, and it is stated wished to unite the two kingdoms; but however well meant his aims were, his method of procedure was unfortunate, as, by attempting to rule the religious instincts of the people, he stirred up opposition, and the strife became renewed, and was continued in the reign of his son, whose further attempts to impose the southern liturgy upon his subjects in the north was met with a robust Presbyterian defiance, which took a public shape in the well-known scene in St. Giles' Church in Edinburgh. The National Covenant was signed by all ranks, and thus we are brought to the Covenanting times, when again the religious aspirations of the country were attempted to be dominated by force, and for years we read of little but strife with tongue and sword, English, Scottish, Highland, and Irish troops all marching and countermarching about the country.

In the reign of the English Commonwealth, Cromwell invaded the country, and, it is said, conceived the idea of uniting the three kingdoms. The restoration of Charles II. took place, but unfortunately the same religious spirit of intolerance was abroad, so that an Archbishop of Glasgow, in 1662, gave orders to shut up the churches until Episcopal incumbents could be got to fill them; fines and

imprisonment were now common for religious nonconformity, and the Covenanting struggle was renewed with special severity in the west country. The Bass Rock was a state prison; torture was applied to refractory prisoners, for these were days of rude and ready methods to effect their objects, when men's passions were aroused.

Later on we find the tide of battle rolling in the North and in the West Highlands, ending for a time in the battle of Killiecrankie, in 1689. The reign of William III., Prince of Orange, began to have an influence in quieting the country, Glasgow being granted—for its loyalty—a new charter, whereby the citizens were conferred the power of self-government in the choosing of "their own magistrates, provost, bailies, and other officers." In reference to the troublous times in Scotland, in the latter part of the seventeenth century, Woodrow, in his *Church History*, says: "This rising in the west of Scotland, like many other considerable turns, had but very small beginnings; and it is scarce to be thought that the persons concerned in them had any prospect that what they did would have been followed with what succeeded." Woodrow then goes on to recount that about eighty armed persons, avoiding Glasgow in consequence of hearing that the king's troops had come there from Lanark, went to Rutherglen, "a small royal burgh two miles from Glasgow," where they affixed to the market cross a declaration, entitled "The declaration and testimony of some of the Presbyterian party in Scotland; published at Rutherglen, May 29th, 1679." This declaration, after referring to the "testimony of faithful witnesses from the beginning against adversaries to the church and king-

dom of our Lord Jesus Christ in the land," goes on to state that "we judge it our duty (though unworthy, yet hoping we are true members of the Church of Scotland) to add our testimony to those of the worthies who have gone before us, in witnessing against all things that have been done publickly in prejudice of his interest," thereafter particularizing certain Acts which had been passed, amongst others, one for "overturning the whole covenanted reformation," and another for "outing of the faithful ministers who could not comply with prelacy, whereby 300 and upwards of them were illegally ejected;" they then publicly burned the Acts at the cross of Rutherglen.

The publication of this declaration caused a great stir in the country, and Graham of Claverhouse—afterwards created Viscount of Dundee—started with a troop of horse and foot, passing through Hamilton and Strathaven, where, hearing that a preaching was to take place at Loudon Hill, to the west of the latter town, he marched in that direction. Public worship had been commenced when the military appeared; but those who had arms, some forty horse and 150 or 200 foot, left the meeting and boldly went to meet the soldiers, and, after a short but sharp conflict, caused them to retreat, rescuing also some prisoners whom Claverhouse had formerly taken. Some relics of the fight may still be seen at the farm of Lochgoin, principally the flag and drum of the Covenanters:—

> "You'll marvel when I tell ye o'
> Our noble Burley and his train,
> When last he marched up through the land,
> Wi' sax-and-twenty Westland men.

Than they I ne'er o' braver heard,
For they had a' baith wit and skill;—
They proved right well, as I heard tell,
As they cam' up ower Loudon Hill."

Claverhouse retired to Glasgow, and the forces there barricaded the town, in expectation of an attack, which came off a few days later, the Covenanters having received additions on the way. "About ten of the clock the country men came to Glasgow, and divided themselves into two bodies. The one under command of Mr. Hamilton came up the street called the Gallowgate; the other party came in at the head of the town, by the wynd head and college. The country men showed abundance of courage, but were under mighty disadvantages. Their horses were of no use to them at all; they were perfectly open to the fire from the closes and houses, as well as that of the soldiers who lay behind the rails and barricadoes covered from their fire." After a short fight, being unable to overcome the defences of the troops in the town, the country men retired, and afterwards marched back unmolested to Hamilton, where they encamped.

A royal proclamation was, after these events, issued on June 3d, 1679, in which Charles, after referring to this rising, states that "We, out of our royal tenderness for the peace and quietness of our ancient kingdom, being careful to repress the said rebellion, and that simple and unwary people be not ensnared by the said rebels, and their emissaries, and involved in their rebellion, and to take off all pretence of ignorance or excuse, do therefore, with advice of the lords of our privy council, declare the said insurrection to be an open, manifest, and horrid

rebellion, and high treason." This was followed by others later on, calling out the militia and the heritors to fight on the king's side. A good deal of marching and counter-marching then seems to have gone on with the troops, so as to make head against the proclaimed movement. Some skirmishes took place in different parts of the country, and finally we find that "The king has also thought fit to name the Duke of Monmouth general to command all his forces, so long as his grace shall remain in Scotland."

The "west country people" were all this time receiving reinforcements; a number of whom did not seem to be very clear upon the origin of the rising. "They reckoned them a body of people appearing for the Presbyterian interest, and in hazardous circumstances at present, whom the king's army would swallow up unless assistance were given them; and therefore resolved to hazard themselves in their defence, not knowing what Providence had to bring forth from these small beginnings." Although numbers appeared in this way to have gathered, yet the absence of suitable arms, recognized officers and discipline, made them less formidable than otherwise they might have been. A declaration of their objects was proposed to be drawn up, but no final agreement could be come to. On 19th June the Duke of Monmouth set out with his army towards Hamilton, but appears to have been troubled with the commissariat arrangements; the bread had fallen short, the blame being laid on the bakers. The immediate result of all this was the well-known battle of Bothwell Bridge, fought on 22d June, 1679.

In an article on "Freedom of Bequest," by I. S. Leadam,

we find the following remarks bearing on the rise of commercial activity after the troublous times had passed (*Contemporary Review* for January, 1888): "Many writers have dwelt upon the invasion of England by Scottish talent which marked the last century and stirred the spleen of Dr. Johnson. In the seventeenth century the law of 'legitim'[1] had enabled the cadets of Scottish houses to equip themselves for commands in the army of Gustavus Adolphus or for service in the Scottish Guard of the French kings. The activity of Scottish enterprise which followed within a generation of the pacification of Scotland was due, no doubt, to the comparative excellence of their education. But their education itself sprang, as influences for refinement commonly do, from social and economical circumstances. To originate a national education a people must have attained a certain uniform grade of well-being. Though not high, and in the eyes of *grands seigneurs* of England and Ireland pitifully scanty, such existed through the law of 'legitim' among the people of Scotland. Out of this arose that intellectual force which has for so many years given the Scottish race, when account is taken of its numbers, indisputably the first place in the empire in general progress and contentment."

The energy of the citizens of Glasgow was now turned to the improvement of their harbour accommodation, and in 1695 ground was purchased at the village of Newark (now Port-Glasgow) for this purpose. The stirring military events of 1715 and 1745 did not improve business

[1] The writer says "In Scotland the legitim has existed from time immemorial as 'bairns' part of gear."

matters; but after the country had again settled down to peaceful avocations we find the spirit of enterprise abroad in the great undertaking of the Forth and Clyde Canal, which was begun in 1768 and partly finished to near Glasgow in 1775, and afterwards to the Clyde at Bowling in 1790, where, on the arrival of the first vessel from the Forth, a barrel of water of that river was poured into the Clyde as symbolical of the now completed union of the eastern and western rivers. The canal is about 35 miles long, and has 39 locks. The greatest height above the sea is 156 feet. Its course is on historic ground, passing as it does pretty much along the line of the Roman wall. There are many aqueducts spanning streams, one of the largest being over the Kelvin at Maryhill, where the canal is carried across a wide and deep ravine at a height of 83 feet.

The Monkland Canal was completed in 1791. Its course is from the northern part of the city eastwards to the great mineral fields in the neighbourhood. A connection with the Forth and Clyde Canal is formed to the west of Port-Dundas. At one time passengers were conveyed along these canals in swift boats, and until a year or two ago a passenger screw-steamer plied from Port-Dundas to Kilsyth, a Saturday afternoon trip with which formed a most enjoyable outing, as both the scenery and historical associations were sufficient to interest the passenger.

These swift boats with their horses and riders formed a pretty sight as they sped smoothly along the waters of the canal, and were probably last seen on the Crinan Canal before the twin-screw *Linnet* had displaced the

old *Sunbeam* with its horses and red-jacketed riders. It is said that one of the old riders of the swift boat horses, on hearing some one spoken of as a man before the mast, said, "Oh, I was a man before the boat."

The manufacture of cotton and other materials became established in Glasgow, and commercial enterprise had now assumed such a position that the merchants founded the Chamber of Commerce in 1783. In the beginning of the present century the manufacture of gas for illuminating the city was commenced, and a canal made between Glasgow and Johnstone, the route of which is now traversed by the Glasgow and South-Western Railway. Water-works were also established, and in 1812 the introduction of steamboats on the river effected great commercial changes. In 1818 the Union Canal, connecting Edinburgh with the Forth and Clyde Canal at lock 16, was commenced.

Much interesting information as to the condition of engineering and manufactures forty or fifty years ago may be obtained by looking over the mechanical journals of the period, where we see the gradually awakening scientific knowledge shown in the many inventions for utilizing the forces of nature to more advantage than in the older times. Chemistry, as applied to the arts in dyeing and bleaching; improvements in spinning and weaving; the use of iron for ship-building; higher pressure and greater economy in the use of steam at sea; the extension of the railway system; the electric telegraph; the introduction of gas for lighting; machine tools and labour-saving appliances; all such subjects are written upon and discussed, with descriptions of the inven-

tions themselves. Sometimes even in these early days the brilliant idea is thrown out of aerial flights, and drawings of proposed machines given. Progress, however rapid since these times in all directions of land and sea transit, has not achieved the power of flying, although theories of flight are not awanting; the old-fashioned balloon, floating at the mercy of the aerial currents, is still the only means whereby we can travel above the earth's surface.

The waterproof material invented by Mr. Mackintosh was soon taken up by ingenious persons in various ways. One proposed to make bags of it and apply them to float ships up the shallower parts of the Clyde. Another saw a splendid future for it not only in life-saving apparatus, but as a means to render the Glasgow people practically amphibious when they went to the coast, "sporting on the surface of the water with as much safety as on dry land." Another proposal was made by one evidently more of an equestrian turn of mind, viz. to have waterproof bags on each side of the rider, which he could inflate on coming to a river and then plunge fearlessly in. In the inventor's description we get a glimpse of the way in which the comparatively new steamboat method of locomotion was regarded at that time (1825), as he goes on, when describing his apparatus, to say: "Whenever danger is apprehended on board a Steam Boat, no delay should be made in putting on the Life Preserver; indeed, were it constantly worn by those who are much exposed to the chance of being thrown overboard, it might save many a valuable life." He then goes on to show what a safeguard it would be in a

crowded vessel where fire occurred, or when that dreaded catastrophe, the bursting of the boiler, happened. The dwellers on the Clyde, however, have not taken the hints thrown out to render themselves unsinkable in sport or danger. The Americans seem to have found it necessary to provide more fully against steamboat disasters than ourselves, as the traveller on the rivers there finds life-preservers in the form of belts and jackets ready to his hand on board, and even printed directions in his state-room instructing him in the proper method of buckling on the armour provided for him.

MINING AND METALLURGY.

Burton in his *History of Scotland*, in speaking of the gold of the Leadhills district, says: "Bishop Leslie describes the streams of the Lanarkshire heights carrying so much of it in the gravel brought down by the floods as if each were a very Pactolus; but he makes a significant admission in telling us that the sifting of this gravel for gold is the occupation of the poor." "Lead was extracted at a very early period in the district of the present Wanlockhead mines. The method of separating any portions of silver that might be in the matrix of lead must have been early in use, as the royalty established in favour of James I. applies to those mines where 'three halfpennies of silver may be fined out of the pound of lead.'" The mining industry at Leadhills is still prosecuted with vigour, the lead ore being the principal, or, indeed, the only commercial product; although, besides lead, other metals are occasionally ob-

tained. Gold is still sometimes found, but no special process is adopted to prosecute this part of the mining operations. The gold found appears to be got only in drift, not *in situ*. There are altogether between two and three hundred persons employed, and the quantity of lead ore mined yearly amounts to about 2500 tons. The ore is smelted by the company working the mines, viz. the Leadhills Silver-lead Mining and Smelting Co. Ltd., and yields from 77 to 78 per cent of lead.

The basin-like nature of the coal-field of the Clyde valley is very well illustrated by the section (see figure, page 43), where it will be seen that the coal beds are disposed in such a manner that the various characteristic seams are met with at different depths, depending upon the position in the basin or valley. The coal beds are known commercially by certain names, the principal being the Upper, Ell, Pyotshaw, Main, Splint, and Virgin coals. The Upper coal was so named as being the first found worth working. At 100 feet or so beneath this we come on the Ell coal, named in this way because it was the first found of that thickness; the thickness of the seam is, however, often about 5 feet. The Pyotshaw seam lies about 50 feet below this, and is 3 or 4 feet in thickness. At a few feet below the latter we come on the Main coal, so called, it is said, from its possessing all the good qualities of the others, or from the fact that in the oldest mining locality in the north-west of Lanarkshire—about Airdrie—the Main and Pyotshaw seams are together, and form the thickest bed. It is considered a most profitable seam to work, its thickness being fully 4 feet. At about 60 or 70 feet further down the Splint

coal is reached, having a thickness of about 5 feet. Close below this is the Virgin coal, after which we come on a seam of ironstone, the most famous in this locality, being the Blackband discovered by Mushet in 1805. What is known as the "Palace Craig Ironstone" lies above the Upper coal, and is worked at Palace Craig, between Coatbridge and Holytown. The average depth of the coal-pits is about 80 fathoms. The depths of the coal seams vary very much, due to disturbance, differences of several hundreds of feet of level below ordnance datum being not unfrequent within short distances. A larger *fault* bounds the coal-field on the south side of the river, extending from a point a mile or so to the south of Glasgow eastwards to beyond Hamilton. Smaller *faults* cross the river at Glasgow Green, above Bothwell, and below Larkhall.

A bed of coal called the Humph, about 30 inches thick, occurs between the Main and the Splint, but has not been much worked except in the neighbourhood of Glasgow, where it is found to be a capital house coal. These upper coal-measures do not extend beyond Glasgow to the westward, as their boundary, at least on the south side of the river, is the *fault* crossing the Clyde close to Glasgow through the Green. To the west of this we come upon the lower coal-measures, or "Possil section," lying under the series of strata which correspond to the "Millstone Grit" of England. These beds contain the fire-clays found about Garnkirk and Glenboig, and extend from the lower slaty-band ironstone to the Cowglen limestone, which is the top of the lower coal-measures. Further west, about Jordanhill,

we are in the Possil section, and at Knightswood a gas coal was worked which has been identified by Mr. Ralph Moore, H.M. Inspector of Mines, with the Lesmahagow gas-coal. The coal-seams down to the Splint do not extend under the river much, if any, past a 25-fathom *fault*, crossing the river near Larkhall; but they appear several miles further south-east on both sides of the river, while the lower coal-measures exist about Douglas and to the south of Lesmahagow. They are not met with anywhere on the Clyde above the village of Hazelbank.

The position of the principal seams in the Clyde valley may be shown in sectional order, thus:

Upper Coal, ...	2 ft. to 5 ft.
Intermediate Strata, 20 to 25 fathoms.	
Ell Coal, ...	5 ft. to 7 ft.
Intermediate Strata, 6 to 8 fathoms.	
Pyotshaw Coal, ...	2 ft. 8 in. to 4 ft. 6 in.
Intermediate Strata, varying up to 5 fathoms.	
Main Coal, ...	3 ft. 6 in. to 4 ft. 8 in.
Intermediate Strata, 7 fathoms.	
Humph Coal, ...	About 30 inches.
Intermediate Strata, 5 fathoms.	
Splint and Virgin Coal, ...	5 ft. to 7 ft.

The fire-clay deposits to the north-east of Glasgow are of great commercial value, a large industry existing in the making of retorts, drain-pipes, fire-bricks, &c. The clay, after removal from the mine, is broken up and put through the crushing-mill, and after being properly treated passes to the moulder. The brick moulds are mostly made of brass, an allowance of one twelfth being made for shrinkage. The moulded material is then stove-

dried and thereafter burned. The kiln contains many thousands of bricks, and is fired gently at first for about two days, after which it is put on full fire for two other days, thus being brought up to a white heat; gradual cooling thereafter being allowed.

The following description of the geological position and method of mining fire clay is taken from a paper on "Fire Bricks," read by Mr. James Dunnachie, of Glenboig, before the British Association, Glasgow meeting, 1876.

"The fire-clays wrought in the neighbourhood of Glasgow are situated geologically in the upper coal series and limestone series, taking the Roman cement as the dividing line, or, according to the Ordnance geological map, in the millstone grit. They are found at all depths, from the surface opencast workings, to pits of 40 or 50 fathoms. They are sometimes taken from lower depths where coal is being wrought, but we do not find our best qualities in such positions. The workable seams vary in thickness from about 3 feet to 30 or 40 feet. The process of fire-brick making is pretty much alike all over the West of Scotland, and indeed everywhere else, when fire-clay is the material employed; but as it is necessary to be clear and connected, we will follow the process as applied at the Glenboig Star Works, near Coatbridge. The clay is there found 113 feet deep, and varies in thickness from 6 to 9 feet. In descending the shaft, we pass through from 12 to 20 feet of floating whinstone (the overflowings of the numerous trap dykes which intersect the strata of the district), this covers a considerable part of the Glenboig field; under the whin are numerous beds of fire-clay and siliceous rocks, some of

them almost pure silica of the true ganister type. The system of mining is what is called stoop-and-room, or pillar-and-stall. The workings are 12 feet wide, and the stoops left in are 30 feet square, excepting at the pit-bottom, where they are much larger. The stoops may be cut through, and when the proper time comes, removed altogether. The clay, in its natural state, is very hard, and requires to be blown down with gunpowder. The clay is sent out in pieces about the size of good round coal. It is raised to a high pit-head platform, from whence it is run either to the crushing-mills direct, or to the bing where it is exposed to the action of the weather. When weathering is adopted, the extra labour of lifting and laying is involved; but the ease with which the milling is afterwards effected fully compensates. When the clay is mixed with 'bullets' or nodules of iron, or any other visible impurities, weathering permits of these being picked out. It also disintegrates and softens the clay, so that a much solider body and smoother surface can be given to such articles as require these qualities. In bricks for general furnace purposes we do not want a close texture. The brick must have sufficient flour in it to give it toughness and strength, but that accomplished, our aim is to make it as rough and open in the grain as possible, that it may be the better able to resist high and variable temperatures. The crushing and milling are effected by means of revolving pans, in which heavy iron-edge rollers run. The crushing-pan is 7 feet in diameter and perforated in the bottom; the crushing-rollers weigh upwards of 3 tons each. The wet pans are 6 feet in diameter, and the rollers weigh 35 cwt. each.

They receive their motion from a large shaft running overhead, connected with the fly-wheel of the engine."

The iron industry has long been established in the Clyde valley at such centres as Gartsherrie, Summerlee, Langloan, Calder, &c., and such towns as Airdrie, Coatbridge, Wishaw, &c., have grown and prospered through the work of the blast and puddling furnaces.

The following extract, which is of interest in connection with the early process of manufacture of iron, is given in the *Journal of the Iron and Steel Institute* for 1887, and refers to a statement submitted to parliament entitled:

"The case of Importation of Bar-Iron from our own Colonies of North America. Humbly recommended to the Confidence of the present Parliament by the Iron-Manufacture of Great Britain. 1756.

"In the year 1751. Application was made to Parliament for the Admission of Bar-Iron *Duty free* from our own Colonies. And after various Struggles, as is always the case, between Self-Interest and the Public Good, the contending Parties seemed to compromise the Difference, —By passing a Law for importing Bar-Iron *Duty free* into the Port of *London only*, continuing the Restraint against all the other Ports of the Kingdom.

"The only Indulgence, which could be obtained at that Juncture, was a Permission to Import *Pig-Iron* Duty-free into other Places.

"It is a *fact* that the Iron-Manufacture in *England* is increasing every Day; So that the Demand for Raw Materials is growing greater and greater.

"The first Process is to refine the Iron from the Ore,

by running the Metal into short pieces like Billet-Wood called Pig-Iron; and the proprietor of this Work is termed the *Furnace-Master.* But Note. The only Fuel proper for this Operation is *Wood Charcoal.* The next Process is to meliorate the Iron, still by means of a *Charcoal* Fire, to render it malleable, and draw it out into Bars by the Strokes of the Great Hammer; The Owner of which Work is stiled the *Forge-Master.* But, generally speaking, the same Person, or Persons, united in a Company, are the Proprietors of both Works: And perhaps of Slitting and Rowlling Mills besides; whose common Appelation is therefore, That of *Iron Masters.*"

The "Case" then goes on to state that in the next place there are the *Iron-Manufacturers* who receive the material to make into "Bars, Rods, or Plates, and work it up into all the various Implements for which *England* is now become famous over all the World." It is then noted that after the iron comes to be dealt with by the Manufacturer "the Use of *Wood Charcoal* is from thence-forward entirely laid aside, and that they perform all their Operations with *Pit-coal;*" and this is shown to have an important bearing on the question at issue, as the price of Cord-Wood in England *necessary* for the making of the charcoal, had more than doubled, and from this and other reasons the "Iron-Manufacturer" greatly suffered, hence it is evident that the "Manufacturer" who did not require charcoal in his operations, was much interested in getting a plentiful supply of plates and bars to work up with the pit-coal which was abundant at home.

An additional argument for drawing closer to the Colonies for supplies of iron was the "present alarming

Connection of Russia with France," this position being illustrated by what had been done in regard to pitch and tar, "when *Sweeden*, under the influence of the same constant Enemy, endeavoured to distress us in the Use of these necessary important Articles."

At that time four tons of pig-iron were allowed for making *three* tons of bar. It appears that at that time foreign iron paid a duty of £2, 8*s.* 6*d.* per ton, and freight from America was at the rate of 25*s.* to 30*s.* per ton as cargo, if in ballast from 6*s.* to 8*s.* per ton.[1]

[1] The following complete description of the introduction of the hot-blast into the smelting furnace is given in the Statistical Survey for Scotland :—

"*Neilson's Patent Hot-Blast.*—An improvement of national importance has lately taken place in the making of iron, of which the following is a description. Mr. James B. Neilson, engineer in the city, obtained patents in this country and France, for an improvement in the manufacture of iron, which he designated a Hot-Blast. The patentee drew up a description of this improvement, of which the following is an abridgement :—

"In 1824 an iron-maker asked Mr. Neilson if he thought it possible to purify the air blown into blast-furnaces in a manner similar to that in which carburetted hydrogen gas is purified; and from this conversation Mr. Neilson perceived that he imagined the presence of sulphur in the air to be the cause of blast-furnaces working irregularly, and making bad iron in the summer months. Subsequently to this conversation, which had in some measure directed his thoughts to the subject of blast-furnaces, he received information that one of Muirkirk iron-furnaces situated at a considerable distance from the engine did not work so well as the others; which led him to conjecture, that the friction of the air, in passing along the pipe, prevented an equal volume of the air getting to the distant furnace with that which reached the one situated close by the engine; and he at once came to the conclusion, that, by heating the air at the distant furnace, he should increase its volume in the ratio of the known law according to which air and gases expand. Thus if 1000 cubic feet, say at 50° of Fahrenheit, were pressed by the engine in a given time and heated at 600° of Fahrenheit, it would then be increased in volume to 2·1044, and so on for every thousand feet that would be blown into the furnace. In prosecuting the experiments which this idea suggested, circumstances, however, convinced him that heating the air introduced for supporting combustion into air furnaces would materially increase its efficacy in this respect; and, with the view of putting

As the older manufactured products and the machinery used have been for many years well known and frequently illustrated, it may only be necessary to state generally the industries carried on in the Clyde district; amongst these we have iron smelting, malleable and cast iron manufacture; the construction of machinery for various purposes, such as marine and locomotive engines, cranes and machine tools; the building of iron bridges and roofs, together with ornamental castings, sugar-mill and refinery machinery, nails, rivets, and iron tube making, wire-work, railway plant, calico-printing, and

his suspicions on this point to the test, he instituted the following experiments:—To the nozzle of a pair of common smith's bellows, he attached a cast-iron vessel heated from beneath in the manner of a retort for generating gas, and to this vessel the blowpipe by which the forge or furnace was blown was also attached. The air for the bellows having thus to pass through the heated vessel abovementioned, was consequently heated to a high temperature before it entered the forge fire, and the result produced in increasing the intensity of the heat in the furnace was far beyond his expectation, whilst it made apparent the fallacy of the generally received theory, that the coldness of the air of the atmosphere in the winter months was the cause of the best iron being then produced. But in overthrowing the old theory he had also established new principles and facts in the process of iron making; and by the advice and assistance of Mr. Charles Macintosh of Crossbasket, he applied for and obtained a patent as the reward of his discovery and improvement. Experiments on the large scale to reduce iron ore in founder's cupola were forthwith commenced at the Clyde Iron-works, belonging to Mr. Colin Dunlop, M.P., and were completely successful, in consequence of which the invention of Mr. Neilson was immediately adopted at the Calder Iron-works, the property of Mr. William Dixon, where the blast, by being made to pass through two retorts placed on each side of one of the large furnaces before entering the furnace, effected an instantaneous change both of quantity and quality of iron produced, and a considerable saving of fuel. The whole of the furnaces at Calder and Clyde Iron-works were in consequence immediately fitted up on the principle of the hot-blast, and its use at these works continues to be attended with the utmost success. It has also been adopted at Wilsontown and Gartsherrie works in Scotland, and at several works in England and France."

chemical products, soap, soda, bleaching-powder, confectionery, dyeing, fire-clay goods, galvanizing, glass manufacture, pottery, leather (saddlery, belting, &c.), oils and colours, paper-making and paper-staining, brewing and distilling, publishing, type-founding, rope, twine, and sail-cloth, flour-milling, saw-milling, tobacco, snuff, tobacco pipes, cotton, woollen, and other textile fabrics. Improvements on many of these industries are from time to time being made. A few of these demanding more special attention may be noticed.

One of the most important is the great extension of the steel industry of late years. The introduction of complete and special plant in works around the city, at an immense outlay of capital, has enabled the Clyde district to produce great quantities of the material known as "mild steel," not only for the plates of the great ships and boilers built on the river but for shipment abroad. The principal process used in this district is the Siemens or open-hearth system. The furnace is lined with a refractory siliceous material, and is charged with pig-iron and scrap, and subjected to the intense heat arising from the combustion of a current of heated gas and air. To remove the carbon, iron ore is added. After the whole is melted and brought into a state of practically pure iron, the necessary quantity of carbon and manganese is then added in the form of ferro-manganese or spiegeleisen, and the whole poured into moulds.

The Bessemer process so largely worked in England, and recently introduced again in Scotland at the Glengarnock Iron and Steel Works, consists in filling an iron vessel called a converter, lined with refractory material, with

molten pig-iron, and then subjecting the liquid mass, weighing several tons, to the oxidizing influence of a strong blast of air forced through the iron by means of powerful air-compressing machinery. After about twenty minutes of this action, during which the flames and sparks arising from the rapid chemical actions going on constitute quite a pyrotechnic display, the metal is brought into a comparatively pure state, after which a quantity of melted spiegeleisen is added, and the now constituted steel is run out into moulds.

The invention of Messrs. Thomas & Gilchrist, whereby the phosphoric iron ores, so common in some parts of the country, can be utilized for the production of steel, has given an increased facility for manufacture of this material. The essential peculiarity of this process lies in the nature of the lining of the converter, in this case a basic material being used, such as magnesian limestone. In the ordinary Bessemer process, where hematite pig is used, the lining is, as already mentioned, of a siliceous character. The ingots, after being reheated (where the Gjers soaking pits are used this is unnecessary), are hammered and rolled into plates, bars, rails, &c.

Steel, from its greater strength over iron, weight for weight, can be used with much advantage for ships and boilers, since many steel-built vessels, although going ashore, yet remain sound, the steel plates being bent but not fractured. The saving of weight by using steel instead of iron for ship-building is said to amount to about 16 per cent. The following descriptive notes of the works of the Steel Company of Scotland may serve to convey some idea of the resources now in the hands of the steel-

maker for the production of this material. These works, besides being the earliest to be started in the Clyde district, may be taken as representative in their general arrangement of the others which have arisen from time to time to the east of Glasgow:—The Hallside Works of the Company are situated near Newton Station, on the Caledonian Railway system, about seven miles south-east of Glasgow. They were commenced in 1871, for the manufacture of steel by the Siemens process. There are now in use in the melting department 17 furnaces of 13 tons capacity, and in the steel foundry one 10-ton and one 15-ton melting furnaces. Their production of steel, when in full work, is about 2000 tons weekly. There are two 12-ton, one 10-ton, and one 4-ton hammers for the production of slabs, blooms, and forgings; two 26-inch plate mills, one 28-inch cogging mill, one 28-inch mill for rails and heavy sections, one 18-inch and one 14-inch bar mills. There are two sets of Gjers soaking pits, and the necessary reheating furnaces for ingots, slabs, &c., and one plate annealing furnace. There is also a foundry for the production of steel castings of the largest size, having a complete arrangement of drying stoves and annealing furnaces. A large machine-shop has just been erected for the completion of the heaviest crank shafts, and is being fitted with the best machine tools for doing this class of work. Besides this there is a complete establishment for conducting the necessary chemical analysis and mechanical tests, as also repairing shops, including pattern, smith, boiler and machine shops.

The Blochairn Works of the Company are situated on the north-eastern outskirts of Glasgow. They were

purchased by the Company in 1880, and remodelled for the production of steel. There are now in use 13 steel melting furnaces of 13 tons, and one of 4 tons capacity, equal to a total production of 1600 tons of ingots weekly. Besides this there are two 12-ton and one 7-ton steam-hammers for preparing slabs, blooms, &c.; two 26-inch and one 32-inch plate mills, two 22-inch plate or sheet mills, one 16-inch bar and one 10-inch guide mills. There is also a universal mill for the rolling of bars up to 24 inches wide, and one 32-inch cogging mill for preparing slabs for the different mills. There are also two sets of Gjers soaking pits, which deal with almost the whole of the ingots made, and the necessary reheating furnaces for slabs, &c., and an annealing furnace for plates, &c. The works also embrace a plate flanging and stamping department, fitted with Tweddel's flanging-press and the necessary machines for planing and turning the edges of the flanged plates. Among other necessary adjuncts are a chemical laboratory, a mechanical test-house, and an iron foundry, with pattern, fitting, and smith shops, &c. The tests to which the finished steel plate, rail, &c., are subjected are various. Strips are cut from the plates and subjected to bending tests and to tensile tests; in the latter the ultimate strength is recorded, and the percentage of elongation. The strength varies from 27 to 31 tons per square inch, with 20 per cent of elongation in a length of 8 inches. The drop test for rails is 1 ton, falling from a height of five feet.

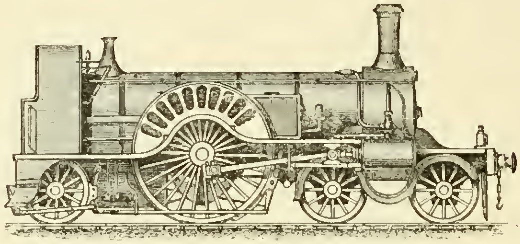
Another important and widely-spread industry of comparatively recent origin is that of the extraction

of paraffin from shale, originally invented by the late James Young. The shale is placed in specially constructed retorts and subjected to heat, whereby the constituents are liberated; and after being variously treated by distillation, refrigeration, &c., the commercial product of paraffin, so much used now for candles, paraffin oil, so excellent for lighting and heating, and ammonia, &c., are obtained. The great fields of this industry lie on the north-eastern boundary of the Clyde valley, at Addiewell, Bathgate, &c.

Not only is the manufacture of iron from the ore carried on in Glasgow and the neighbourhood, but the remelting of the "pigs," so made in the cupola, is carried out in many foundries throughout the city; great castings of cylinders and their accompaniments for the Atlantic liners, pipes for water and gas, from the great four-foot diameter drysand casting, down to the one-inch diameter greensand casting. The pipe-founding trade has long been a speciality in Glasgow, its originators having, like their industrial brethren the ship-builder and engineer, made for themselves, by their skill and enterprise, a wide reputation. This we see is still maintained; for we notice lorries, each with a single 12-foot length of huge iron pipe slowly being drawn by a sturdy Clydesdale to the river for shipment, or the lines of railway trucks with their corresponding loads, all for great water supply works at home or abroad.

The forging of iron under the powerful stroke of the steam-hammer is also a speciality, as in the Lancefield Forge the shaft of the *Great Eastern* was turned out for that big ship.

The building of locomotives is considerable in Glasgow; thus the various private firms in the city can turn out as many as 450 completed engines in the year. Besides



Passenger Locomotive Engine.

this, the works of the railway companies are engaged in making and repairing both engines and carriages.

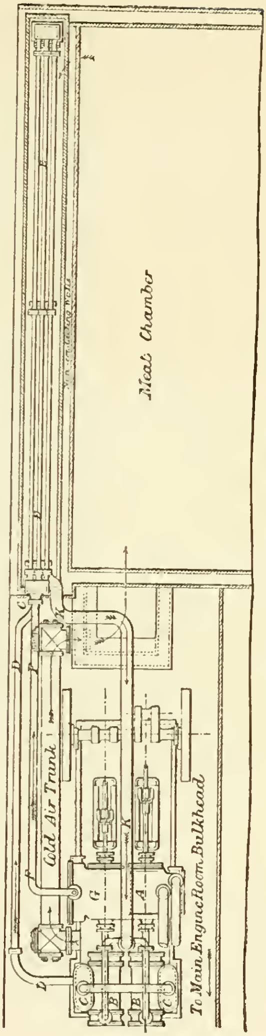
The utilization of the waste gases from the blast furnaces has also been largely worked out; so that instead of the wide-mouthed flaming tower-like structure illuminating the country for miles around, we have a close-topped furnace with a bell and cone arrangement for charging the ore, the waste gases which formerly were consumed in flame at the top being led off to heat the blast and raise the steam required for the blowing-engine. And recently, as a further improvement, plant has been laid down at several works for the recovery of ammonia from the gases.

Explosives in the form of gunpowder and dynamite are manufactured on a large scale on the Firth of Clyde—gunpowder at Kames, in the Kyles of Bute, and dynamite at Ardeer, Stevenston, where the works of Nobel's Explosives Company are situated. Dynamite is

a pasty substance composed of nitro-glycerine and an absorbent earth, and is of great advantage to the engineer and others, not only from its greater power than gunpowder, but from its explosive qualities being unaffected by damp or water.

Amongst some of the more recent industrial achievements which belong to the Clyde district, the Bell-Coleman method of preserving meat fresh by the circulating of air at a low temperature may be mentioned. Several years ago the process was first applied in sea-going vessels by the inventors, a cargo of meat being brought home from Australia and delivered in prime condition. Now the method is widely developed, and the mechanical application appears in different forms and for different purposes.

The Industrial Museum



Bell-Coleman Refrigerating Machine.

A, Steam cylinder; B, Air-compressor; D D and K K, Connecting-pipes; C, Cooling Tower; E E, Drying-pipes from tower; F F, Return pipes to Expansion Cylinder; G, Expansion cylinder.

in Kelvingrove Park, belonging to the Corporation of Glasgow, though small, contains an excellent assortment of the leading manufactured products of the city. A short but lucid descriptive *Sketch Guide*, by Mr. James Paton, F.L.S., the superintendent, enables the visitor almost at a glance to carry away a very fair idea of the commercial variety in manufactures carried on in the city.

Chater VIII.—METEOROLOGICAL, &c.

The Firth of Clyde presents some peculiar features which are of much interest. The long narrow lochs which stretch like arms for many miles inland, carry the sea-water to the foot of the Highland hills of Argyleshire, and, in the combination of mountain slopes and salt-water with the tidal ebb and flow, are, in a miniature form, a reproduction of the fiords so common on the Norwegian coast. In many cases the latter still terminate in the great ice-field or glacier, with snow-clad mountain summits. The Clyde hills, however, unless in winter, are free from snow or ice. By the student of geology many traces can still be seen around these inlets that point to a time in the far-back history of our river, when the glacier slowly crept down the valleys, the ice sheet being floated away down to the opener waters beyond, carrying with it some of the debris from the mountain slopes. Speaking of the glacier period, Mr. Bell, in his *Rocks around Glasgow*, says:

"So issuing in great volume from the mountain ranges by the channels of these Highland lochs, Loch Fyne,

Lochs Ridden and Striven, Loch Eck and Holy Loch, Loch Goil, Loch Long, the Gareloch, and Loch Lomond—all of which are simply old glacier beds—the ice spread across what is now the Firth of Clyde; part, as we have seen, taking an easterly and south-easterly direction, and part, also, as shown by the markings on either shore, proceeding down what is now the channel, past Bute and the Cumbraes. There must, therefore, have been a 'shedding' or parting of the ice near Gourock, and this may be one reason why the boulders there are so abundant. At Kilmun point, where the Loch Eck and the Loch Long glaciers coalesced, there would be formed a 'medial moraine,' which would be borne by the ice across the present channel, and strewn where it impinged on the slopes of the opposite hills."

The deposits left by these movements are partly of a clayey nature, and a classic interest surrounds certain beds which are found on the banks of the river and firth; and it is to the late Mr. Smith of Jordanhill that we owe the discovery of shells of an Arctic type which had lain embedded since the glacial period, contemporary living specimens being only now found in Arctic regions. These shells can still be found in the beds of clay at various points, one of which is at the mouth of the Balnikailly Burn, Bute, which enters the Kyles nearly opposite Colintraive pier.

Whether as a student of geology, natural history, or, shall we call it, climatology, an observer will find much of interest in the configuration of the lower part of the Clyde, from where Loch Long terminates at Arrochar to the Craig of Ailsa itself, which may be considered as the

terminal mark of the firth. If anyone will take a chart of the firth and note the soundings he will observe a varied assortment of figures, with here and there a characteristic letter attached. The figures represent in fathoms the depths below low water, and the letters indicate the character of the bottom. If we now compare these varied depths we may notice that, although the depth increases in a general manner as we recede from the shore, yet, at the lowest part of the firth, and where we would naturally look for the deepest water, we have very much shallower water than at many points higher up the firth. Thus, if we take a line across from Girvan by Ailsa Craig to Campbeltown or the Mull of Cantyre, we find that the soundings there vary very little, preserving a fairly uniform value of 25 or 26 fathoms (immediately outside it is 50 fathoms), while some miles higher up, off Arran, they increase to about 70 fathoms, attaining at the north end of that island to 90 fathoms, which again is exceeded in Loch Fyne, at a point a few miles below Tarbert, by the great depth of 104 fathoms, or 624 feet. And thus one of the two great chimney-stalks in Glasgow, which measures about 450 feet, would, if placed in the water out at Ailsa Craig, have from about one-half to three-fourths of its height above water, but would be completely submerged if placed off the north end of Arran; and in Loch Fyne, at the point of greatest depth mentioned, it would be covered by about 170 feet of water. Such a configuration points to a deep basin of water lying more or less up the firth from its termination; hence if a sufficiently great ebb-tide were to lay bare the plateau around Ailsa Craig, there would

be left inside an inland lake which, at its deepest part, would be about 470 feet deep. Indeed, if we consider that the level of the water has undoubtedly stood at one time much higher than it is at present, Loch Lomond will afford us an illustration of such a changed condition of things, as it is obvious that at one time what we now see as a fresh-water lake must have been an arm of the sea not unlike Loch Long, and, indeed, might now be united to it, as the narrow neck of land which divides these two large sheets of fresh and salt water is not greatly raised above sea-level. The deepest part of this inland and fresh-water loch is over 100 fathoms, its lower part being separated by 6 or 7 miles of low-lying ground from the river Clyde.

Besides this general depression in the firth there are also subsidiary depressions at different points in the arms or lochs already referred to; thus, the inner part of the firth, or that lying above the Cumbrae Islands, shows this same basin-like structure, as we find deeper water about Dunoon than at Toward Point; a little off Dunoon we find 56 fathoms, but off Toward Point 23 fathoms.

From the north end of Greater Cumbrae an elevation all within the 20-fathom line runs northwards till it reaches its highest part at Skelmorlie Buoy, on the bank of the same name, where the depth is only $2\frac{3}{4}$ fathoms, it then slopes down rapidly to 44 fathoms off Wemyss point. A deep channel exists on the Skelmorlie shore, which, along the measured mile course, varies from 38 to 45 fathoms.

Starting with the Gareloch, the highest up of the sea lochs, and just at the commencement of the firth, we find

that the entrance, which is narrow, has only a depth of a few fathoms, 1 to 5, whilst about half-way up the depth reaches 23 fathoms. At the entrance to Loch Long the greatest depth is from 32 to 33 fathoms, whilst 44, 46, 48, and 50 are registered up towards the mouth of Loch Goil. Considerably deeper water is also found in this short loch or arm of Loch Long than at its entrance. The Holy Loch is short and shallow, a depth of 14 fathoms being pretty uniformly preserved throughout its centre.

The next important arm of the firth is Loch Striven, which runs back among the Cowal hills for a distance of about 7 miles, and exhibits in the grand and lonely character of its scenery much of that for which some of our far west Highland lochs are justly celebrated. The deepest sounding at the mouth of this loch is 23 fathoms, deepening rapidly to 35 fathoms, and reaching to 40 and 41 fathoms about half-way up.

Coming to Loch Fyne, which stretches as a long narrow valley far up into Argyleshire, we find that in the upper part, viz. that running in a somewhat north-easterly direction from Otter, near Ardrishaig, to beyond Inverary, we have at the narrow part of Otter Ferry an irregular series of soundings varying from 6 to 23 fathoms, whilst fully half-way up the depth reaches 82 fathoms. At the mouth of the lower part of Loch Fyne we find the greatest depths marked to be 79 and 84 fathoms, the greatest depth, as before stated, being found higher up, and reaching to 104 fathoms, the depths above and below this point being 96 fathoms. (See Chart of Firth, p. 16.)

Now, it is obvious that not only the peculiar superficial

configuration of this system of sea-water into which the river Clyde flows, but the peculiar characteristics of the bottom must affect the flow and ebb of the tide and the temperature of the water. The tidal wave as it reaches our coasts is deflected around the northern and southern ends of the island, and in like manner, to a smaller extent, suffers considerable interruption to its course on entering the Firth of Clyde by the Mull of Cantyre. Passing up from the North Channel the island of Arran divides the stream, one part reuniting again at the north end of that island and passing up Loch Fyne and through the Kyles of Bute, the other part flowing past the Cumbrae Islands and advancing up the upper lochs and the river itself till reaching Glasgow.

The temperature of the deep water in the Firth of Clyde and the neighbouring sea lochs has recently formed the subject of careful experimental investigation, and the conclusion drawn from the data obtained recorded in papers and reports. These interesting researches were first begun in 1886, when the steam-launch *Medusa* cruised about the firth and neighbouring lochs, taking deep-water soundings and gathering much general and useful information both as regards the waters and the creatures which live in them. From these observations it was found that the distribution of temperature depended largely on the depth and form of the sea bottom. Surface temperature was lost at 10 fathoms down. The temperature on the shallowest part off the Craig was higher than at the bottom of the lochs. Speaking on this subject Dr. Mill says:

"The work has so far brought out the following quite

new results. The temperature in the open channel south of the Mull of Cantyre is always nearly uniform from surface to bottom; it changes regularly with the advancing season and appears to be higher all the year round than the mean of that of equally deep water anywhere inside the Clyde Barrier Plateau. In the great Arran Basin temperature is uniform from surface to bottom for a considerable time when the warmth is at a minimum in early spring. As the weather grows warmer the surface heats most rapidly, and the warmth slowly spreads downwards, affecting the whole mass of water below the depth of about 30 fathoms uniformly and slowly at first; but the distance to which a rapid rise extends increases until past the autumnal equinox. Then the surface commences to cool, the maximum occurs at the middle, but is speedily transferred to the bottom, and gives the early winter distribution of increase of temperature with depth. Cooling ultimately takes place throughout until an exactly uniform vertical distribution is established. The deep rock-basins resemble the Arran Basin with its peculiarities relative to the open Channel much exaggerated. They are comparatively isolated from tidal influence, and exposed to the extremes of summer heat and winter cold from the proximity of steep mountainous walls down which much surface water pours. The deep basins have a strong resemblance to inland lakes in their great range of temperature at the surface and small range at the bottom. The intermediate layers usually show remarkable instances of the superposition of strata at different temperatures. The phenomenon of a cold layer sandwiched between warmer ones, and gradu-

ally sinking lower as summer advances, is characteristic of all rock-basins filled with sea-water, but was not so marked this year as last in the Clyde lochs."—*Journal of the Scottish Meteorological Society* for 1886.

There appears to be about $3\frac{1}{2}$ per cent of salt in the waters of the firth, and the deeper water is, in all cases, salter than the surface water. In many cases calm patches of water are noticeable on the surface when otherwise there are ripples due to the wind, also oily-looking patches scattered about on calm days. These patches may sometimes be noticed when becalmed while yachting, and if closer attention be paid a distinct up-welling of the water at these places can be detected. During the cruise of the *Medusa* such patches were investigated, and it was found that in one case, off the Mull of Cantyre, the temperature of the patch was 42° to 42°·3, whilst that of the surrounding water was 43° to 45°·5; the conclusion drawn by the observers was that such appearances were due to the deeper and therefore colder water welling up from the bottom.[1]

The rise and fall of the tide around the coasts of the firth is very varied on account of the configuration of the

[1] Professor James Thomson, of Glasgow University, considers this uprise of water to be due to "impulses arising through the scouring action of the current along the bed. Thus the water so arriving at the surface and spreading out there is composed largely of the deadened water from the bottom." As to the calm patches, Dr. Thomson says: "The water must often be affected by various causes, such as tides, breezes, currents, and circulation due to differences of temperature, so as to be made to rise occasionally at some places and sink at others. Now along the line of meeting and sinking of two opposing surface currents all floating objects carried by these currents will be collected together, and there they will act as dampers or floating breakwaters for the small ripple undulations."

channel; the action of the wind, too, has much to do with the range. In looking over a chart of the firth we see that near the southern end of Bute the range is 10 feet, at Ardrishaig from 6 to 9 feet, at Inverary 10 feet, Loch Striven head 6 feet, Lochgoilhead 6 to 10 feet, at Arrochar 12 feet, and at Greenock 10 or 12 feet. At West Loch Tarbert the tides are so irregular that the familiar practice of beaching lighters to tranship their cargoes, so common on the shores of the firth, cannot be carried out, at least with the certainty of a rise of tide at a stated time to get afloat again. The range there is only from 1 to 4 feet. About Loch Crinan it appears to vary from 3 feet at neap-tides to 8 feet at springs. At the Mull of Cantyre the range is only 4 feet at springs. At the Cumbrae Head the range of the tide at springs is about 12 feet. At Toward Point the greatest range, which is in March, is about 14 feet with a north wind. If the wind be southerly the ebb will be reduced by as much as two feet. Around Ailsa Craig there appears to be little or no range of tide. The speed of flow is, however, from 4 to 5 miles an hour.

The influence of the wind is very marked in such narrow channels as occur about the firth. Southerly gales happening at the time of springs, frequently cause flooding of the lower parts of our coast towns, whilst extreme ebbs occur with easterly winds, causing difficulties sometimes in the launching of vessels on the river, and in the taking of some of the coast piers by the river steamers.

Where there is an island with a long narrow channel at one end, we find that part of the tide coming up the

firth keeps to one side of the island and part to the other, like the island of Bute, where it meets at a point in the Kyles about Southhall; yachtsmen and fishermen, who are more or less dependent on the wind and tide, can in this way gain advantage of the direction of flow of both flood and ebb.

The times of high-water are also very varied. Thus, at Ardrishaig, Kyles of Bute, Garroch Head and Loch Striven head, the time of high-water is much the same, but at Skipness and West Loch Tarbert it is about three hours later; at Inverary, Lochgoilhead, and at Greenock, it is about a quarter of an hour later.

The effect of wave action is often experienced on the Firth of Clyde, the passage between Gourock and Dunoon and the rounding of Toward Point having been long dreaded by passengers to Rothesay, as also the rounding of the Farland Point going to Millport, and the side sea experienced crossing at Wemyss Bay. The winds which produce this disturbance are from the southward, having a long fetch from the outside part of the firth, accompanied, it may be, by a ground-swell from the deeper water outside. During the ebb-tide, with a southerly wind, the effect is intensified, the waves being higher and sharper. It is well known that the judging of the height of waves is deceptive, and great variety exists in individual minds as to the size of waves even with those accustomed to see them. Thus, in the firth, within the Cumbraes, heights of from 8 to 12 feet are quoted by steamboat captains and others conversant with the firth in storms, whilst outside and beyond Arran 12 to 15 feet is assumed as an approximation. It is unlikely, in the

inner waters of the firth at least, that such extreme heights as 12 feet are met with, from 6 to 10 feet being more probable. No doubt where the water shoals the tendency of the wave is to rise and break; thus in a southerly gale one experiences the sharpest heave off the buoy on Toward Bank.

Where the waves are unaffected by special tidal action, the rule devised by Mr. Thomas Stevenson, C.E., appears to give fairly accurate results for the height of waves in heavy gales, viz.:

$h = 1\frac{1}{2}\sqrt{d}$, where h=height of wave in feet, and d=fetch in nautical miles. Applying this formula to the waves coming up the channel, it appears that for a height of 6 feet the fetch would require to be 16 miles, and for a height of 8 feet $28\frac{1}{2}$ miles.

It is generally recognized that there is extreme difficulty in estimating approximately correct the heights of waves at sea. A sensitive aneroid, however, readily indicates the rise and fall of the ship, and might be employed for such investigation. As a kind of gauge of the height of the waves in the inner parts of the firth, it may be often noticed by passengers on rough nights who cross from Wemyss Bay that the light on the floating gas buoy on Skelmorlie Bank disappears regularly with every wave. Now, as the height of the light is 14 feet above sea-level, this indicates a considerable apparent height of wave. This buoy carries a bell for fog-signalling, and being specially rounded off below to intensify its swinging tendency in a swell, we cannot take the whole 14 feet as representing the difference of level from trough

to crest; but, as the buoy is more or less inclined, something less would indicate a real height of wave as already noted from direct observation.

The meteorological conditions of the Clyde valley are somewhat varied, arising largely from the variations of altitude of the different parts of the country through which the river takes its course and the direction of the hill slopes which border it. In the Upper Ward, which extends down to Carluke, a great part of the country is moorland and rough pasture, but the soil in many places is well suited for cultivation, the principal part of the arable land lying near the Clyde. The soil becomes more clayey as the boundary of the middle ward is approached, which, although showing great variety, yet is principally clayey. Alluvial soil is met with near the river and its tributaries, and a peaty earth is common in some parts. In the lower ward the soil varies from clay to sand, with alluvial bottoms along the Clyde.

The weather of the Upper Ward is steadier, and the cold and heat more severe than lower down, and heavy rains frequently fall in the higher parts. In the lower parts of Lanarkshire the temperature is modified by the influence of the Atlantic.

Looking over such reports as those published by the Meteorological Society of Scotland we see the great variation of temperature and rainfall in the different districts where records are kept. Thus, if we take the report for the year ending December, 1885, we find that at Ardrossan, on the eastern side of the firth, the annual rainfall amounted to 30 inches. Crossing the country to Paisley we find registered 33 inches; at Gasgow, 27 inches.

Following up the line of the Clyde valley we have at Cambuslang, 26 inches; about Bothwell, 22; Hamilton, 29. Keeping by the coast we find at Rothesay, 44 inches registered; at Greenock, celebrated as a rainy place, we have the large quantity of 56 inches; at Helensburgh, on the opposite side of the river, 48 inches; and at Arrochar, at the head of Loch Long, the great quantity of 71 inches fell in one year, or nearly 6 feet of water. By the time we get up to Dumbarton we find that only 42 inches were registered. Very nearly the same quantity of rain was registered on opposite sides of the Clyde valley at points roughly north and south of Glasgow; thus at Mugdock, near Milngavie, 8 miles from Glasgow, where the service reservoir of the Loch Katrine water supply is situated, the rainfall was about 42 inches, and at Ryat Linn, another of the Glasgow reservoirs, but connected with the Gorbals works on the south side of the river, a few miles from Glasgow, the rainfall was about 41 inches; Glasgow, as already stated, coming in between these two stations with 27 inches.

The variations of monthly mean temperatures in degrees Fahrenheit throughout the year at various points in the Clyde valley and firth are as follows:—[1]

	Jany.	July.	Range.
At Mull of Kintyre,...............	37·4	56·0	18·6
„ Corsewall,......................	37·7	56·9	19·2
„ Pladda,..........................	37·0	55·7	18·7
„ Lamlash,........................	39·4	56·1	16·7
„ Rothesay,.......................	36·0	56·6	20·6
„ Greenock,.......................	35·4	56·7	21·3
„ Helensburgh,..................	34·1	55·6	21·5

[1] Rainfall for 1886.—*Journal of Scottish Meteorological Society, 1886.*

	Jany.	July.	Range.
At Dumbarton,........................	35·2	57·8	22·6
„ Paisley,............................	35·6	58·6	23·0
„ Glasgow, ...	34·6	57·6	23·0
„ Wanlockhead (1334 feet),...	27·4	53·8	26·4

The island of Bute has long been celebrated for the salubrity of its climate, and is well known as a health resort. The climate is mild, as the following notes of temperature will show: thus, the average temperature of Bute, taken over a period of nearly fifty years' observation, is given as 47°·34, the highest of any year during that time being in 1828, when the average for that year was 50°·73, the lowest average being 43°·40 in 1838. The highest average temperature for July during that time was 63°·09 in 1852, and the lowest average temperature for December was 31°·81 in 1874. The highest temperature recorded during the same period was 85° and the lowest 14°. The rainfall is much less than at some points on the mainland adjoining, the average fall taken over a large number of years giving 48·32 inches.

Freedom from sudden changes of temperature is undoubtedly favourable to longevity, rapid variations affecting the death-rate in a marked manner. The following extract refers to the salubrity of some of our western islands:[1] "The islands of Bute, Arran, and Mull are peculiarly adapted as sanatoria for consumptives, and their climates are highly conducive to restoring energy in cases of lowered vitality and nervous exhaustion. . . . After a most careful study of Rothesay and its surroundings,

[1] *A Treatise on Medicated Respiration in Pulmonary Consumption.* By Anthony Bell, L.R.C.P.E.

climatically, geographically, and socially, I am not surprised at its being designated 'the Madeira of Scotland.' . . . I must not neglect to mention the pleasant village of Port-Bannatyne, situated at the head of the beautiful bay of Kames, about two miles from Rothesay, rendered charmingly picturesque by its brilliant scenery, including the far-famed Kyles of Bute. During the summer months the air at this health-inspiring spot is purer than Rothesay, and certainly more buoyant and invigorating."

From a voluminous report on the weather of 1886 by Professor Grant of the Glasgow Observatory, published in the *Glasgow Herald*, it appears that the average annual temperature at Glasgow for the last ten years was 46°·4. During 1886 the maximum temperature in the shade was 76°·7 in July; the minimum, also in the shade, being 15°·3 in February. The maximum in sun was 131°·1 in July. The highest reading of the barometer was 30·681 in November; the lowest reading being 27·647 in December; the monthly range of the latter month being 2·843 inches, and the average range for the year being 1·453 inches.

The rainfall was 32·179 inches, the greatest fall being in September, when as much as 4·958 inches fell during a period of 16 days. The least fall was in April, the depth during that month being 1·160 inches, distributed over a period of 12 days.

The prevailing winds were from the south-west and north-east, the former blowing during 84·29 days and the latter 79·43 days. The least frequent were the south-east winds, showing 14·5 days, and the north-west, 17·46 days. There were 64·92 days of west wind, and 37·29 of east wind; 43·21 days of south wind, and 23·90 of north wind

An interesting tabular statement gives the movements of the air, from which it appears that the average hourly movement for a period of 10 years was 11·6 miles per hour, the highest being in 1877 with 13·2 miles per hour, and the lowest in 1879 with 10·9 miles. The mean temperature during 1886 was highest with the south wind, which gave 49°·45, and lowest with the east wind, which showed only 43°·67. The south-west wind was the wettest, giving 8·57 inches of rain in the year, and the north-west wind the driest with 0·74 inches, and the north wind with 1·21 inches. The percentage of possible sunshine for the year 1886 was 22·4.

Glasgow and the Clyde valley are occasionally visited by strong gales, a pressure of as much as 55 lbs. per square foot having been recorded at Glasgow Observatory. During a severe storm in January, 1868, 42 lbs. was registered. During the memorable Tay Bridge storm a pressure of 37 lbs. was recorded, but the fury of the storm so damaged the instrument that a complete record could not be obtained. After the inquiry as to the cause of the Tay Bridge accident the Board of Trade determined to adopt 56 lbs. per square foot of surface as the wind pressure to be allowed for in designing structures such as bridges. In 1881 a severe storm registered a pressure of 48 lbs. per square foot, the wind travelling with a velocity of 80 miles per hour. This was quite a hurricane in intensity if we take 10 lbs. per square foot as equal to a strong gale.

Sometimes the nature and velocity of the wind are given in tables with the corresponding pressures. Thus, a "light breeze" has a velocity of about 7 miles per hour,

and giving a pressure of about a $\frac{1}{4}$ of a lb. per square foot of vertically-exposed surface. A "fresh breeze" is double this velocity, but the pressure is now *four times* what it was at 7 miles. A "strong breeze" is about 20 miles per hour: "gales" range from 25 to 45 miles per hour; whilst storms and hurricanes rise beyond this to as much as from 60 to over 100 miles per hour, with wind pressure of 20 to 60 lbs. per square foot. The pressure varies generally as the square of the velocity, and may be approximately represented as follows:—$p=\frac{V^2}{c}$, where $p=$ pressure in lbs. per square foot and $V=$velocity of wind in miles per hour. The constant c seems in some cases to be about 100, and sometimes almost double that.[1] Professor Grant has kindly informed the author that the expression $p=\frac{V^2}{100}$ agrees better with experiments made at Glasgow Observatory than $p=\frac{V^2}{200}$, but that he has not arrived at any relations between the two elements which can be regarded as definitely satisfactory.

The very heavy storms which come upon our coasts appear to partake more or less of the character of cyclones, as from the tendency to veer in varying directions during the time of blow, a distinct rotatory and progres-

[1] If we consider that the pressure of a flowing body such as air may be calculated from the momentum of the mass in motion, then we have $p=\frac{(wv)\,v}{g}$, where $p=$pressure in lbs. per square foot of surface, $w=$weight of a cubic foot of air (say ·08 lbs. for dry air), $v=$velocity in feet per second, and $g=$gravity, or say 32·2. It will be found that the above formula will resolve itself practically into $p=\frac{v^2}{400}$; or, if we take the velocity in miles per hour, $p=\frac{V^2}{200}$.

sive motion is indicated. This veering tendency is sometimes marked in heavy storms by the direction of fallen timber, in some cases one tree lying across another, showing the movement of the wind.

The great and memorable storm in which the Tay Bridge fell began on the west coast as a strong south wind about 2 p.m., and gradually shifted round to west and north-west, increasing in intensity till about 7 or 8 p.m., when it decreased.[1] The law of such storms has now been ably investigated, and instructions drawn up for the guidance of the mariner at sea, showing how he should steer to get out of the spiral or circle of storm influence.

The herring fishing industry in the Firth of Clyde has long been an extensive one, and the fame of the Loch Fyne herring is known far and wide. The migratory tendencies of this fish are but little known; but the quality and size appear to vary in some measure with the locality around our coasts where the shoals congregate, the distinctive characteristic of the Loch Fyne herring being its delicate flavour and small size. This industry, like all fishing more or less, varies much in its results. Thus the quantity of herrings cured on the west

[1] The whirling motion seems in the northern hemisphere to be in a direction *against* the hands of a watch, and the advance from west or south-west to east or north-east, whilst in the southern hemisphere the rotatory motion is in the opposite direction, or *with* the hands of a watch. It appears that the lines of equal pressure during such storms are more or less of a circular character, the lowest pressure being at the centre. The general tendency of the wind during rotation is to blow slightly towards the centre. The changing condition of the weather also may be noted in such whirling and progressive gales commencing from the south with rain; as they veer to the west and north-west the wind becomes more squally, with showers, and eventually, as it gets more northwards, clears off to dry weather.

coast in 1886 was about 170,000 barrels; whilst in 1885 there were as many as about 254,000 barrels. Although such a great difference is seen in the total, yet it appears that on some parts of the coast, such as Kilbrannan Sound, the fishing was prosperous in 1886.

The following yearly average from published statements shows for a period of fifty years back the quantity of herrings cured in the west of Scotland:—

1836 to 1845 inclusive............	72,145	barrels per annum.
1846 to 1855 inclusive............	83,500	,, ,,
1856 to 1865 inclusive............	114,997	,, ,,
1866 to 1875 inclusive............	165,982	,, ,,
1876 to 1885 inclusive............	209,703	,, ,,

The herring fishing is prosecuted in the Firth of Clyde by means of wherry-rigged half-decked boats of 6 or 8 tons, and by smaller boats carrying lug sails. The drift nets are shot about sundown, and drawn about sunrise. The system of trawling is, however, now much in vogue, and has largely displaced the drift-net fishing; but in the opinion of some of those who should know, the herring caught by the trawl method are inferior to the drift-net herring, as the blood does not get out at the gills as when caught in the mesh. The herring fishing in the firth commences in June and used to end in January, but is now sometimes carried on to March.

On looking over the fishery statistics, it is most astonishing to note the quantity of fish of all kinds taken around our coasts and the value of this sea harvest. Thus for one month only (September, 1887), the total value of the fishing around the Scotch coasts was over £123,000, and of this the herring value was fully one-

half, or over £66,000. Haddocks were nearly one-half of the herring value. Of this fishing the east coast share was by far the largest, the value of the herring caught there being about £40,000. Shetland and Orkney had the high figure of £12,000, and the west coast £14,000. Of this the Firth of Clyde gave £12,000 alone.

It appears that the value of the fish of all sorts landed on the Scotch coasts during the ten months ending 31st October, 1887, was:

East coast,..	£891,525
West coast,..	£205,183
Orkney and Shetland,..............................	£121,700
Giving a total of..................................	£1,218,408

Dr. John Murray, of the *Challenger* expedition, in speaking of the feeding grounds of the herring and salmon, says that the ridge, 25 fathoms from the surface, which separates Loch Fyne from the ocean, causes a marked difference between the well-known herrings of that loch and those of the outside western lochs. Dr. Murray believes that the Loch Fyne herrings do not quit the loch at all, but that after spawning they go down to the deep water of the loch and remain there feeding in quiet, rising afterwards to the warmer waters of the surface for the purpose of spawning. Their food appears to be prawns and small crustaceans, and it is due to the superior feeding at the bottom of the loch that these herrings owe their characteristic quality. Oysters beds do not flourish on the Firth of Clyde; but the mussel beds are valuable, the famous mussel banks opposite Port-Glasgow being well known;

and from fishery reports these appear to extend principally on the north side of the river, the space fished extending to about three miles in length by one in breadth. Other beds exist further down in the firth, as at Holy Loch, Blairmore, and Loch Ridden.

Chapter IX.—DEFENCES.

The defensive condition of the Firth of Clyde has occupied some attention recently, and measures have been taken, based upon a government survey and report, to protect the entrance of the river at the Tail of the Bank at Fort Matilda by arranging for the placing of mines. The following extract, from a scheme proposed by Major-general Sir Andrew Clark, Inspector-general of Fortifications, published in the daily papers July, 1885, is of much interest:—

"The vast national importance of the shipbuilding industries of the Clyde, however, and its position as one of the two great western commercial ports of the country, render defence absolutely necessary. During war with a European power the security of the Clyde and Mersey would be vital to the food supply of the people; while the whole of the shipbuilding energies there concentrated would be required to create and maintain the great supplementary force which the peace navy of the country would need. Such a port as the Clyde has, therefore, a military as well as a commercial importance, and its adequate defence becomes a national

necessity. Glasgow, approached by a long, narrow channel, is eminently defensible against a naval attack. There is not sufficient water to allow the larger ironclads to move up the river; the sinking of a single ship would effectually bar the approach; but the maintenance of the free navigation of the Clyde during war is a matter of necessity, and such an expedient is inadmissible, except as a last resort. It becomes necessary, therefore, to create a main line of defence at some point which shall serve as an absolute bar to the progress of a squadron. Such a bar can be created only by heavy guns, in combination with submarine mines. Thus the position selected must lend itself to both these methods of defence." In connection with this it may be stated that there is now a Mining Volunteer Corps, who practise the laying and placing in position of both ground and mechanical mines. These are iron cases filled with guncotton, and can be fired by electricity from the shore.

The strength of the volunteer forces in the Clyde district is as follows:—

Lanarkshire—Rifles,	10,760	
" Artillery,	1369	
" Engineers,	867	
	———	12,996
Yeomanry,		626
Naval Brigade,	about	70
Renfrewshire and Dumbartonshire—Rifles,		3587
Renfrewshire and Dumbartonshire—Artillery,		484

The total strength of the volunteers in Great Britain appears to be about 228,000. The Tactical Society have mapped out the country to facilitate military defensive

operations. The Boys' Brigade movement, started in Glasgow some years ago, now numbers about 6000. The primary object of this movement is to improve the boys morally and physically, but from their great aptness in learning the elements of drill it is likely that the volunteer ranks will be afterwards increased from this body.

The present Fort Matilda is the successor of an earlier battery, erected further up the river in 1763; it was afterwards strengthened during the American war, and replaced in 1812. About the close of the last century, when the stirring events in France led us to fear invasion, a battery of several 18-pounders was placed on the east side of the Bay of Rothesay, some of the guns being still there beside the present aquarium.

We have perhaps the most powerful ship in our navy, the *Ajax*, guarding the river.

> "Lives there a chief whom Ajax ought to dread—
> Ajax, in all the toils of battle bred?"

So spoke Homer of one of his Grecian heroes. The *Ajax* fortunately has not yet been inured to battle; but if ever that time should come when our fleets have to defend their country, we may be sure our Ajax will equal the Homeric hero in valour.

We have also an occasional visit of the Channel Fleet, consisting of half a dozen of our powerful ironclads, broadside or turret ships a great deal more destructive but far less picturesque than the old wooden-walls which came sailing up the river under a cloud of canvas. The great speed of some recently-built war-ships is

specially noticeable—thus the fast cruiser *Australia*, built by Messrs. Napier & Sons for Her Majesty's government, has attained a speed of about 19 knots on a lengthened trial. The new Spanish war-ship *Reina Regente*, built by Messrs. James & George Thomson, Clydebank Works, attained on a four-hour trial an average speed of 20·73 knots, with a maximum of fully 21 knots. As this represents about 24 miles per hour, we have a large and completely equipped war-ship, having a displacement of 5000 tons, with a draught of water of 20 feet, driven at railway speed, with a power exerted by her triple-expansion engines equal to 11,000 horses. Those who have seen this vessel sailing along through the narrow waters of the firth, throwing up a high and crested wave from her bows, which made large vessels plunge and roll, and finally broke along the shore like the surf in a gale of wind, will not readily forget the sight. Torpedo boats show also railway speeds of 25 and 30 miles an hour. Great speed, however, cannot be obtained with heavy armour, and as the guns are likely to gain in power in a faster ratio than the defensive character of the armour, we may yet see history repeating itself; and as the coats of mail of the old knight proved useless against the musket ball, and were in consequence doffed as an encumbrance, so in time the armour plating of our modern war-ships may disappear, and the smart swift cruiser with heavy guns of long range take her place.

All these defences are still thought to be necessary even amid the enlightenment of the present day when the peaceful arts are so largely cultivated. Coleridge

appears to believe in the efficiency of the "silver streak" for defence when he says:

> "And Ocean mid his uproar wild
> Speaks safety to his island-child;
> Hence for many a fearless age
> Has social quiet loved thy shore,
> Nor ever proud invaders' rage
> Or sacked thy towers, or stained thy fields with gore."

The sister ship to the *Australia*, the *Galatea*, has attained on trial a mean speed of fully 19 knots. Like the *Australia*, this vessel is fitted with triple-expansion engines at the suggestion of Dr. Kirk. So that these two ships are specially interesting as the first vessels of her majesty's navy to be so fitted. It further appears from the results of these trial trips that the weight of the engines and boilers was comparatively light for the power developed. The Clyde has also the honour of having first applied the compound engine to her majesty's war-ship *Constance*, which was fitted with these engines by Messrs. Randolph, Elder, & Co. in 1863.

Forced draught is now being used at sea, a comparison of the results obtained by this and ordinary draught in the same vessel being shown in the trials of her majesty's *Galatea*, when, without special air-pressure, the steam-pressure was 130 lbs.; vacuum, 27·825 inches; the revolutions, 101; the horse-power being 5871; the corresponding speed was about 17·4 knots. With forced draught the following results were got: steam-pressure, 138 lbs.; vacuum, 27·195 inches; revolutions, $113\frac{1}{2}$; indicated horse-power, 9219; speed, 19·021 knots; the forced draught equal to 1·15 inch on the water-gauge.

Chapter X.—YACHTING.

The Firth of Clyde, from its landlocked character, and from the numerous fine lochs stretching away inland from its shores, offers special facilities for yachting. These facilities have been abundantly taken advantage of, and the tourist, as he sails down the river on a fine summer day, will see the whole bright and sparkling waters dotted over with the white sails of pleasure-boats, (from the square lug of the small rowing boat to the great "white wings" of the hundred-ton cutter or smart schooner), which, in the far distance, look like veritable sea-birds. Numerous rowing boats are also to be seen, and in holiday times they literally cover the water near the shores. This love of the sea is referred to by Froude in his *Oceana*, where he says: "After their own island, the sea is the natural home of the Englishman; the Norse blood is in us, and we rove over the waters, for business or pleasure, as eagerly as our ancestors. Four-fifths of the carrying trade of the world is done by the English. When we grow rich, our chief delight is a yacht."

Yacht-building has long been carried on, notably at Fairlie, near Largs, where the name of Fyfe has become a household word. Many famous yachts have been turned out by this firm. Glasgow, however, has now done much to bring yacht-building to both structural and scientific perfection; and for successful efforts in this direction the name of Watson is known far and wide. Commencing successfully with the smaller sizes of five and ten tons, Mr. Watson, in the hundred-ton steel cutter

Vanduara, astonished some of the other big cutters that tried conclusions; and recently in the *Thistle*, although unsuccessful against the American centre-board *Volunteer*, excellent results were obtained against cutters of her own class and style of build.

In his large and exhaustive treatise on yachts, Mr. Dixon Kemp says: "Open-boat sailing has long been very popular on the Clyde; and this is hardly to be wondered at, as the firth offers special opportunities for such a pastime—snug anchorages, fairly smooth water, little or no run of tide." "And the facilities given by the railway and steamboat companies for readily getting from the city to the coast, induce most young men who are in the least degree nautically inclined to keep a boat of some sort; and during the summer months, in the bright northern evenings, from every coast village may be seen a fleet of little vessels flitting along the shore in the smooth water, and lying over to the land wind, which in good weather rises as the sun sets."

The racing boats are divided into three classes, the lengths being 17, 19, and 21 feet; the breadths varying from about 5½ feet to 7 feet, and the depths from 3 feet to 4 feet. The lug-sail is principally used. It is of great size, spreading in a 19-feet boat to between 20 and 30 square yards, or say 1½ square yard to the foot of length. An old rule for an ordinary lug, for a 12 or 16 feet rowing boat, was 1 square yard per foot; but these bigger boats are specially ballasted or have metal keels; some also carry shot in bags, which can be shifted to windward, on the principle of sitting up to windward in the ordinary open lug-sail boat. A three-ton yacht

carries about 75 to 80 square yards of lower sail on a water-line of 25 feet, or say fully 3 square yards per foot. A five-ton yacht carries about 3 square yards; a ten-tonner, about 4 yards; a twenty-tonner, $4\frac{1}{2}$ yards; a forty-tonner, 5 square yards; and for a hundred-tonner, about 6 square yards.

These areas are only for the mainsail, jib, and foresail, so that when the yachts are in racing trim the area is very much increased with topsails and other additions. Thus the racing sail areas of the *Volunteer*, *Mayflower*, *Thistle*, and *Galatea* appear to have been respectively 1000 yards, 959 yards, 986 yards, and 833 yards. The length on the load water-line of the first three yachts was about 85 feet, whilst the *Galatea* was about 86 feet. This gives as much as about $11\frac{1}{2}$ yards per foot of water-line. The comparison of sail area with length on water-line is of more importance since the introduction of the new tonnage rule by the Yacht Racing Association, viz.:

$$\frac{\text{Length on load-line} \times \text{area of sails in square feet,}}{6000}$$

The making the sail area a factor in the rating appears to be a sensible movement, as it takes into account the power which drives the vessel, as the marine engineer does when he considers the indicated horse-power required to be placed in his vessel to get the required speed.

Not only has there been a great development in the sailing type of pleasure yachts, but there has been even a greater in that of steam yachts, which now range from the tiny launch of 20 feet or so to the great sea-going vessel of 600 tons. The improvements in boilers and

engines, which have gone on for some time in the mercantile marine, have also been applied to pleasure vessels, and swiftness with economy of consumpt of fuel are now readily obtained. To many no doubt the sailing yacht will always be preferred with its pleasant and buoyant motion, but the steam-launch has a great advantage over the sailing yacht in the many calm days which in summer-time so often beset the yachtsman.

The various yachting clubs have done much to foster and keep alive the love of yachting; and the regattas which are held during summer stimulate improvements to carry off the prizes offered. The forms of yachts have undergone considerable change during late years, a general narrowing of beam having taken place, stability being obtained by increasing the depth; and, for the purpose of keeping the centre of gravity low, the lead in iron and steel yachts has been run into the bottom of the vessel, and in wooden yachts heavy lead keels are fastened on outside.

The tonnage rules for yacht measurement have no doubt had a great deal to do with these tendencies to narrowness, as the length and breadth were the principal factors in determining the tonnage. Now, however, from the new tonnage rule of sail area and length on load water-line, we may expect a change in the form, as designers will be left practically untrammelled as to the form which they may give the midship section of their boats. Thus the *Thistle,* which was built for a special purpose, viz. to attain great speed, with a great carrying power of canvas, has a much greater proportion of beam than the type of yacht so much run after during the past

few years. These remarks apply of course more to racing yachts than to cruising yachts.

The "centre board," of which we have heard so much during the recent contest between the *Thistle* and *Volunteer*, at New York, for the "America Cup," appears to be a very effective arrangement for beating to windward, and, like a great many of our present-day appliances, seems to have been tried many years ago in this country, although not perhaps in the complete manner in which it has now been fitted. It is doubtless a development from the old-fashioned "lee-board," which was fixed on the gunnel, and hung down at the side. The Americans have developed its application in both small sail-boats and large sloops, as they prefer to call their yachts. The centre board has never been a favourite on the Clyde, but in England there are a large number of small boats now fitted with this appliance. Various forms have been given to this arrangement. Sometimes it is of iron and pivoted at the forward end, so that when the after-part is lowered down, the appearance is that of a fin or half the tail of a fish. In some cases the board is made in pieces, fan-like, and can be pulled up to lie alongside the keel, and not up into a well in the boat as in the other cases.

Mr. Dixon Kemp, in *Yacht and Boat Sailing*, says: "A belief sometimes exists that a centre board adds to the stability of a boat. So it does if made of iron or other metal, just the same as an iron or other metal keel would; but if the material be wood, not heavier than water, the tendency of the board would be to upset the boat, as the wood would strive to come to the surface, or, in other

words, to float; thus the larger a wood board were made, and the deeper it were lowered, the more urgent would be its tendency to assist in upsetting a boat. A board, however, causes the process of heeling to be a little more slowly performed, as the board has to be moved through water, and the resistance to the board being so moved is of the same nature as the resistance of the water to any plane moved in it. Thus, when a boat is once permanently heeled, or has settled down on "her bearings," as it is termed, the board will be of no more use for stability, as its tendency will be to float or come to the surface. If the boat is struck by a squall which only lasts, say, four or five seconds, the board may possibly prevent an upset that otherwise would take place; but if the squall continues, and is of a strength to upset the boat without the board, the boat will be assuredly upset with the board, only it may take two or three seconds longer to do so."

Chapter XI.—LIGHTHOUSES.

The lighthouses on the Firth of Clyde provide a complete system of distinctive illumination. Thus, going down the channel from Greenock, we have on the east side the Cloch, white *fixed* light; on the opposite side the Gantocks, 2 fixed *red* lights; and Toward, white *flashing* light; on the island of Cumbrae, the Cumbrae light, white, *fixed;* on Holy Island, 2 *fixed* lights, *green* above and *red* below; on Pladda, 2 *fixed* white lights; on Turnberry Point on the Ayrshire coast, one white *flashing*

light; and on Corsewall, near Loch Ryan, a white and red *revolving* light; on Ailsa Craig, one white *flashing* light; and on Davaar Island (Campbeltown), a white *revolving* light; whilst on Sanda there is a white *intermittent* light; on the Mull of Cantyre, a white *fixed* light; and on Rathlin Island, to the west of the Mull, there are two white lights—the upper *intermittent*, and the lower *fixed*. Besides this there are fog-signalling arrangements at the Cloch, Toward, Cumbrae, Pladda, Sanda, Mull, Ailsa, and Rathlin lighthouses.

Since 1829 a beacon, consisting of a stone tower, has stood on the Gantocks reef. The light, as already noted, is two red lights placed vertically, and is obtained from a gas supply kept in a tank, arranged as in the case of the lighted buoys on Skelmorlie bank and in the river channel above Greenock. The lighting of the river above Greenock consists of Beacons, Ships and Buoys, the lights displayed by these being obtained from gas contained in iron tanks in the two first mentioned; in the latter, the buoy itself forms the tank. These buoys are from 7 to 9 feet in diameter, and contain sufficient gas to provide for burning throughout the whole 24 hours, during periods varying from 7 weeks to 14 weeks. The gas is forced in under pressure until it attains to a pressure of about 100 lbs. to the square inch, the variation of pressure due to reduction in quantity being regulated at the light by controlling apparatus.

The difficulty of giving a distinctive character to the constantly increasing number of lights around our coasts has brought out various suggestions, one of which by Sir Wm. Thomson consists in giving the distinctive character,

by causing the light to blink rapidly or slowly in certain arranged periods. The light on Craigmore pier at Rothesay is of this character. Speaking on this subject, Sir Wm. Thomson, who has devoted much attention to lighthouse characteristics, groups these under three heads, viz.: "I. Flashing lights; II. Fixed lights; and III. Occulting or eclipsing lights." "In the flashing light, the light is only visible for a short time—a fraction of a second, or from that to five or six seconds—and then disappears; and for a much longer time than the duration of the flash it remains invisible, until it again flashes out as before. In the fixed light there is no distinguishing characteristic whatever, but merely a light seen shining continuously and uniformly. Characteristic distinction is given by a short eclipse or by a very rapid group of two or three short eclipses, or of short and longer eclipses recurring at regular periods—'flashes of darkness,' as they have been called—cutting out, as it were, from the light its mark, by which it may be distinguished and recognized to be itself and nothing else, in the very short time (from half-second at the least, to seven seconds at the most) occupied by the group of eclipses." The attempt to distinguish flashing lights simply by their respective length of period was found to require some improvement, and colour in some cases was introduced, and afterwards a system of triple flashes; the latter was found to be the most successful, although in some cases the movement is rather slow to the sailor who is anxiously endeavouring to read his position from the character of the light. In speaking of the occulting or eclipsing lights, Sir Wm. Thomson says, "the only systematic means of giving characteristic quality to a fixed

light is by means of occultations or eclipses; and hence the origin of the 'Occulting' or 'Eclipsing light.' We may, accordingly, look forward to all, or nearly all, the important fixed lights of our coast being, without any very long delay, converted into lights of this class." Several of these occulting lights are now exhibited on the English, Irish, and Scotch coasts.

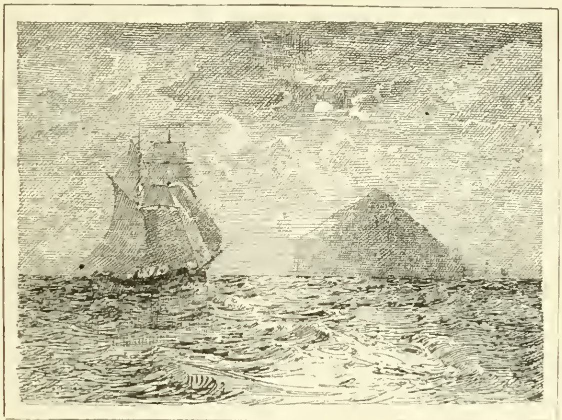
Ailsa Craig, although lying very much in the fair-way of the channel—it is situated about 10 miles west from Girvan and 12 south from Pladda—does not seem to have called for special attention in the way of lighthouse requirements; its great bulk, unless in very dark nights or foggy days, indicating its whereabouts. There were, however, difficulties in dealing with it as a lighthouse station, as from the steep, and in some places precipitous nature of its sides, no point offered itself readily for erecting such a structure. Again, from its great height, the summit was unsuitable, being frequently hid in clouds. Several accidents to vessels having occurred, however, it was determined to erect not only a lighthouse but fog-horns as well, and in 1883 works of this character were commenced and finished in 1886. The light-tower, 25 feet high, is placed on the eastern side, where the only flattish bit of shore exists. It is stated in technical language as "a dioptric third-order flashing white light," which, being placed about 60 feet above the water, has a range of visibility from the deck of a vessel of 13 nautical miles, through an arc of 252°. The light is obtained from the combustion of gas made from mineral oil, this gas is also used to drive the engine for condensing the air required by the fog-horns. Ailsa Craig, therefore, has now

become a centre of applied science, the latest improvements in the machinery required being here developed.

A small ruined square tower, about 40 or 50 feet in height, stands at an elevation of about 400 feet on the east side, and on the opposite side the ruins of what appears to have been a church may be seen. Recently during the excavations required to be made in connection with the new lighthouse and fog-signalling machinery which have been erected on the rock, two ancient graves, containing human bones, were discovered. According to some, the tower referred to was one of the line of watch-towers erected many centuries ago to guard our coasts. Others again regard it as having been a monkish establishment.

In an article which appeared recently in the *Glasgow Herald*, entitled, "A Forgotten Chapter in Scottish History," it appears that Ailsa Craig was the scene of a war-like episode in the year 1597, when Andrew Knox, minister at Paisley, determined to frustrate an attempt by Hew Barclay, Laird of Ladylands, to assist the designs of the King of Spain on this country. The object of the conspirators being "to take and surprise the island and house of Aylsaie in the mouth of the Clyde, a place of great strength." The government of the day remaining inactive Andrew Knox took the matter in hand, and "solved the difficulty by taking possession of Ailsa Craig, at the head of a small body of nineteen men, with whom he stationed himself on the solitary rock to await the course of events. Before long Ladylands, ignorant of Knox's movements, and wholly unconscious of the ambush laid for him, sailed to Ailsa with thirteen of his fellow-conspirators, intend-

ing 'to have fortefeit and victuallit the same for the ressett and comforte of the Spanishe armey, luiked for be him to have cum and arryvit.' On reaching the spit of shingle on the east side, which affords the only landing place, he found himself suddenly opposed by a band of determined men, who at once 'forgadderit with him and



Ailsa Craig.

his compliceis, tuke sum of his associatis and desirit himselfe to rander and be takin with thame, quha wer his awne freindis, meaning nawayes his hurte nor drawinge of his blude.' Though taken at a disadvantage the laird was not of a temper to yield without a struggle; 'withdrawing himself within the sey cant,' he resolutely defended himself against his opponents till, having been forced to retreat step by step to the very edge of the cliff, he was thrust 'backwart in the deip, drownit and persheit in his awne wilfull and disperat resolutioun.' In

the heat of the struggle no attention had been given to the mooring of the boat in which Ladylands and his accomplices had come across. Not till the skirmish had ceased was it discovered that it had drifted out to sea, bearing with it the laird's 'coffers' and the important documents which these were believed to contain. This untoward accident, however, delayed the clearing up of the plot but for a short time. A few days later the masterless craft was picked up off South Annan. In Ladylands' coffers were found, as had been expected, letters which revealed the whole extent and importance of the treasonable scheme in which he had been engaged. It appeared 'that the conspiracye to have been accomplished by the takinge and forcinge of Ailsa was devysed by the larde of Ladylands, Corronall (Colonel) Hakerson, and the Spanish Ambassador.'"

The stone of Ailsa Craig has long been celebrated for the making of curling-stones for the lovers of the "roaring game," which was graphically described some years ago in *Blackwood*:

> "It's an uncolike story that baith Whig and Tory
> Maun aye colly-shangy like dogs ower a bane;
> And a' denominations are wantin' in patience,
> For nae Kirk will thole to let ithers alane;
> But in fine frosty weather let a' meet thegither,
> Wi' a broom in their haun' and a stane by the tee,
> And then, by my certes, ye'll see hoo a' parties
> Like brithers will love, and like brithers agree!"

The curling-stones are quarried out of various parts of the rock, and are afterwards cut and polished principally at Mauchline, Ayrshire. They weigh, when finished, from

35 to 40 lbs., and are generally of a grayish colour shaded with a reddish or greenish hue. As the stone is of a very compact, fine-grained character, they take a fine polish, some of them being highly ornamental in the smoothness of surface and fine tone of colour. The bright polish is reserved for one of the surfaces, say the top of the stone; but as the handle can be shifted from one surface to the other the player can use top or bottom according as the ice is dull or keen.

The rock has a somewhat elliptical base, measuring about 1200 yards long by 750 yards broad; the form is roughly conical, rising to a height of 1114 feet. Geologically it is composed of syenitic trap of a gray colour with reddish patches. On the west and south-west there are precipices, where the rock takes a columnar form.

Ailsa Craig is the home of the solan goose and his feathered relatives, puffins, kittiwakes (white gulls), and guillemots, the familiar "dooker" of the Clyde. The blind-worm, measuring several inches in length, is also common.

Most of the Clyde lighthouses were established many years ago, the present lighthouse on the Lesser Cumbrae[1] being erected in 1757. The old beacon tower on the top of the island was built in 1750.

The Edinburgh Chamber of Commerce were also early alive to the necessity of lighting the coast, for it appears that in 1774 they made a visit to the Isle of May to see what improvement could be made on the uncertain light, due to the burning of coals, already existing on that island.

[1] Dr. Strang says: In 1756 Mr. Oswald, a London merchant, was presented by the corporation of Glasgow with a piece of plate for his services, in obtaining the act for the erection of this lighthouse.

A brilliant electric light is now shown from the lighthouse on the May. It appears that at one time lighthouses were in some cases family property, with a right of toll, from which a rising revenue was obtained. Outlying lighthouses and their keepers are much more exposed to vicissitudes than those on shore. The famous Eddystone has now its fourth tower erected upon it. Winstanley, the builder of the first tower on that rock, perished with his structure in the furious storm of 1703.

Ailsa Craig, like the Bass Rock in the Firth of Forth, stands out prominently to the eye from the wide stretch of water around. The Craig, unlike its eastern counterpart, is not noticeable in the political history of Scotland as a prison-house. In viewing it, therefore, from the swiftly passing deep-sea steamer, or in visiting it with a party of pleasure, there is nothing in the Craig to recall any special events connected with Scottish history or to depress the spirits by the surroundings calling up associations of a grim and hard-hearted past. And so as we see the old Craig looming grandly in the horizon, and watch it as we approach rising higher and higher above the swelling waves of the North Channel, we can look upon it as a magnificent rock standing sentinel-like, always at its post, welcoming the homeward-bound and speeding the departing ship—its great mass, like all simple masses whether of nature or art, satisfying the eye with its large outline, and creating a feeling of restfulness in the beholder.